Product Engineering

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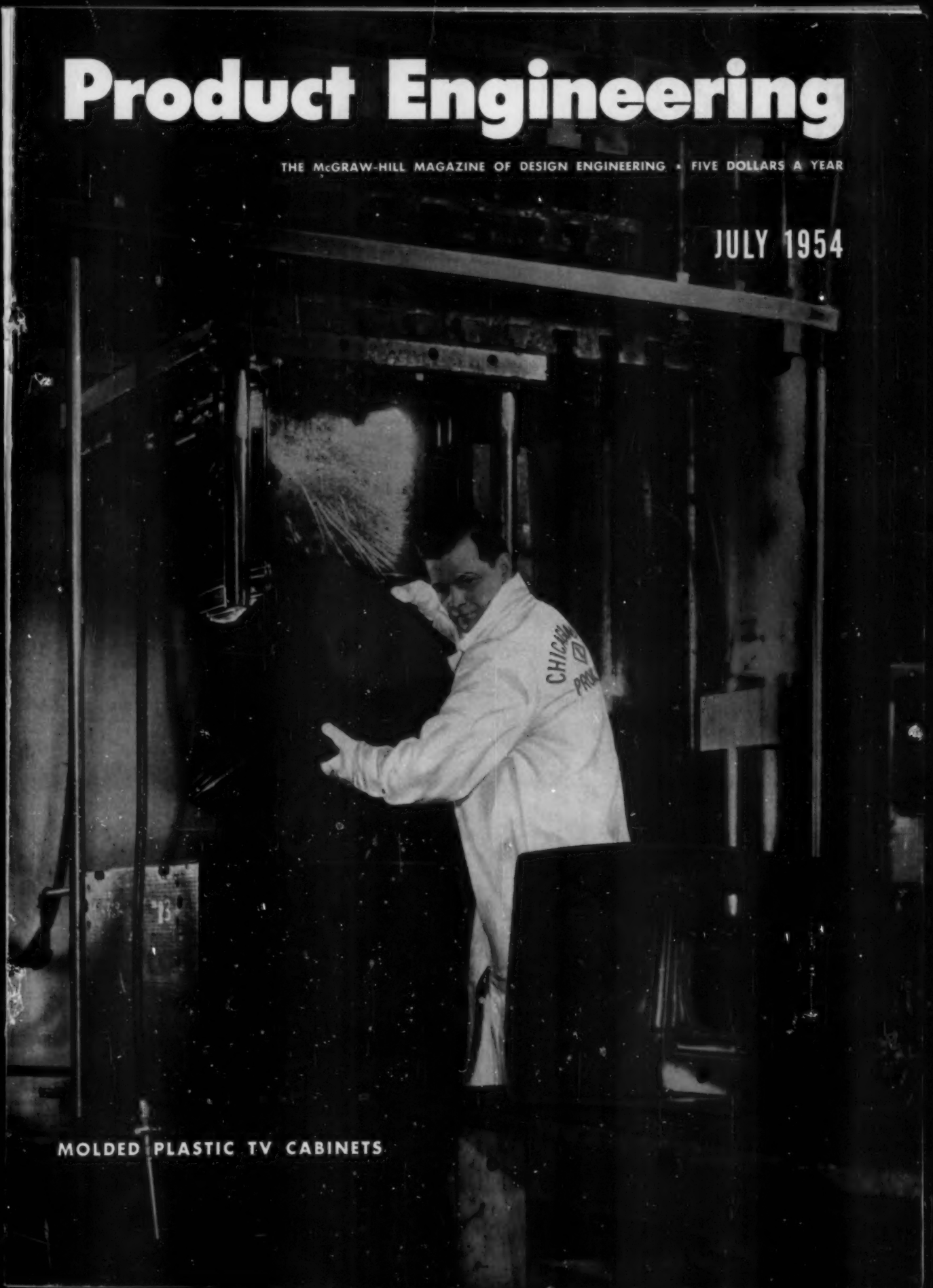
JULY 1954



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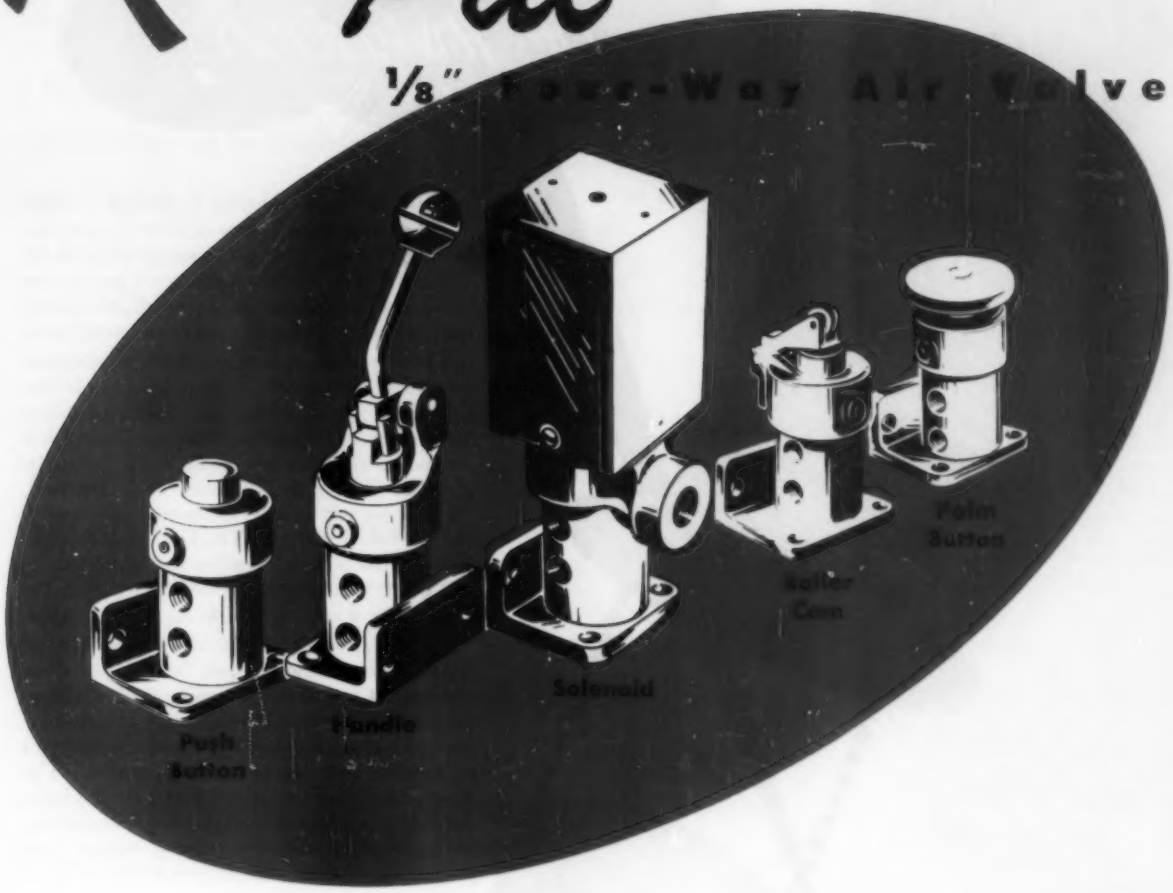

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THIS MONTH'S COVER

The bright red TV cabinets are indicative of the broadening use of lighter colored plastics. While still under development, large thermosetting cabinets in bright or pastel colors can be molded in existing equipment such as this 1,500-ton press at the Chicago Molded Products Corporation, Chicago. These 26-lb cabinets, produced experimentally for Motorola, show the interdependence of designer and molder. Design details include a crowned top and curved sides to eliminate warpage and insure a strong, rigid cabinet as serviceable as it is good looking.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

METALLIC MATERIALS

. . . . Titanium alloy possessing the toughness of high strength steel is a development of the Watertown Arsenal Laboratory, Watertown, Mass. The alloy is reported to have a tensile strength of 192,000 psi and to be corrosion resistant. Most important: it is tougher and more pliable, permitting it to be shaped—thus overcoming the brittleness factor that severely limits other titanium alloys. The alloy is considered a potential substitute for steel.

LOW CARBON FERROCHROMIUM . . . .

. . . . to be known as Exlo—is the latest addition to the alloys and metals developed by the Vanadium Corporation of America, 420 Lexington Ave., New York 17, N. Y. The material is claimed to be clean, dense and low in carbon content (0.025 percent max). Exlo is said to have many applications, including production of top-quality stainless steels of extremely low carbon content for many uses.

MAGNESIA REFRACTORY . . . .

. . . . should be of particular interest to the metalworking field where resistance to basic slags of metals is required. Electro Refractories and Abrasives Corp., 344 Delaware Ave., Buffalo 2, N. Y., believe that the lead industry, in particular, will find it useful in smelting and purifying operations. The refractory is reported to be 97 percent pure and nearly all the impurities are inert, being trapped in the crystalline structure. Material can be used up to 3,600 F.

BERYLLIUM . . . .

. . . . costs are expected to be reduced to about 1/3 to 1/2 of their present price by a new refining process. Light Metals Refining Corp., 20 Exchange Place, New York 5, N. Y., states that the new process is economically practicable for other metals such as, aluminum, titanium and tungsten. A pilot plant is proposed with a production capacity of 10,000 lb per year. A new commercial plant will produce 100,000 lb per year.

ZIRCONIUM OXIDE . . . .

. . . . is being produced that—by spectographic analyses—is 99.2 percent pure. Pure zirconium oxide is useful, according to the Zirconium Metals Corporation of America, Subsidiary of National Lead Co., 111 Broadway, N. Y. 6, N. Y., where extreme purity is required for chemical reactions. It is the starting material for all zirconium chemicals. Also, its monoclinic structure gives it sharper edges making it an ideal polishing agent. Pure zirconium oxide is also useful as a pigment in plastics, ceramics and glasses.

SURFACE HARDENED TITANIUM . . . .

. . . . has potential application for small machine parts and a large variety of bearings and gears. According to the Armour Research Foundation, Technology Center, Chicago 16, Ill., where extreme surface hardness for wear resistance is required, case hardened, unalloyed titanium is probably satisfactory. Surface hardness ranging from 700-800 VHN can be obtained by case hardening with metalloid elements such as oxygen, nitrogen, carbon and boron. Core hardness range is 210-378 VHN. Case depth would vary between 0.001 to 0.003 in. By using one of the new commercial titanium alloys or one of the age hardening alloys as a base and then case hardening, the resultant product should be capable of meeting the most severe application requirements anticipated in future designs using titanium or its alloys.

NONMETALLIC MATERIALS

. . . . HAE comparison studies have been made against: a proprietary caustic treatment in a bath containing caustic soda, water glass and crystalline phenol; an acid dichromatic treatment; and a new proprietary anodic treatment in an acid chromatic bath containing ammonium fluoride, sodium dichromatic and phosphoric acid. Tests were made by the Ordnance Corps, Frankford Arsenal, Bridge and Tacony Sts., Philadelphia, Pa. Parts given the HAE treatment were said to show no attack in a 200 hr salt fog exposure test while other parts showed objectionable corrosive deterioration, particularly those given the standard acid dichromatic treatment.

SHELL MOLDING PROCESS . . . .

. . . . which is claimed to make possible savings of up to 50 percent in resin content by precoating sand with a phenolic resin has been developed by the Bakelite Div., Union Carbide and Carbon Corp., 30 E.

(continued on page 7)

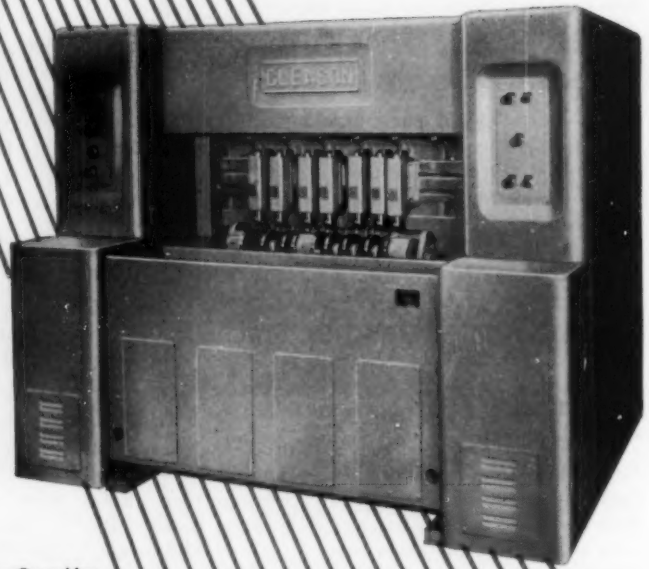
ELIMINATE HEAT TREAT DISTORTION PROBLEMS

GLEASON

QUENCHING MACHINES for ROUND FLAT and SHAFTED PARTS

No. 26 QUENCHING PRESS

No. 16 and No. 36 Quenching Presses also available



No. 140 ROLLING QUENCH MACHINE

The Gleason No. 26 Quenching Press and No. 140 Rolling Quench Machine offer the solution to distortion problems of round, flat and shafted parts. Round and flat parts up to 36" in diameter, or shafted parts up to 4" in diameter and 40" long can be quenched. Both machines are ideal for job lots or high production.

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Highlights

42nd St., New York 17, N. Y. The process consists of the use of a resin-sand mix which allows the formation of strong, light-weight shell molds that produce closer tolerances with less metal, require less machining and have fewer rejects than the green sand process. Also claimed is that the process causes faster melt, faster flow and faster bond than the conventional resin-sand mixtures for shell molding.

RESIN TREATED WOOD . . . .

. . . . is being adopted as the material for die molds used to make steel dies for automobile body parts. The U. S. Forest Products Laboratory, Madison, Wis., report that the material—named Impreg—is being used by the Ford Motor Co., 3000 Schaefer Rd., Dearborn, Mich. Tests indicate that the material shrinks and swells much less than untreated wood now used and thus, speeds production of the die molds.

GLASS TEMPERING . . . .

. . . . can be speeded by using a new radiant heat furnace which tempers sheet glass in about 4 min. Developed by the Selas Corp. of America, 548 E. Erie Ave., Philadelphia 34, Pa. for the Hamilton Glass Co., Vincennes, Ind., the furnace is claimed to be quicker and easier to maintain than the conventional open-flame or electric tempering units. In 4 min the unit will temper a sheet of glass to a strength capable of resisting a 225 lb weight dropped about 4 in.

COMPONENTS

. . . . Electronic comparators have been developed that allow quick comparative checks to be made on chemical composition, hardness, case depth and plating thickness to check part quality. General Electric Co., Guided Missiles Dept., One River Rd., Schenectady 5, N. Y., report that two basic types have been developed—one compares the electrical properties, the other the magnetic properties. In use: an air coil is energized by ac. Coil impedance is affected by any metal placed within it. By measuring the change in impedance, the test piece can be graded by comparison against a known reference standard. For hardness tests the specimen and standard must have identical shape. Comparators can be adapted to the separation of mixed metals and the detection of surface flaws.

BATTERY TERMINALS . . . .

. . . . that are said to be a minimum of 90 percent corrosion resistant and easy to attach and detach are a development of David and Co., Inc., 880 Market St., Paterson, N. J. Terminals have been engineered—for all trucks, busses, air and marine applications—of a special bronze alloy (85 percent copper) that is said not to freeze to battery posts. Units are claimed to save time, effort and expense in changes as well as minimize abuse and damage to batteries and terminal posts caused by corrosion.

ELECTRON TUBE . . . .

. . . . designed to break the internal heat barrier generated by hundreds of tubes confined to a narrow space has been developed by the Red Bank Division, Bendix Aviation Corp., Red Bank, N. J. Tube is claimed to be able to function at a temperature of 572 F for a minimum of 1,000 hr. It is the first heat resistant electron tube, according to the company, ever to be developed for mass production. First application will be in high speed, high altitude aircraft.

A CATALYTIC MUFFLER . . . .

. . . . that is claimed to effectively reduce noxious and irritating components of 4-cycle diesel engine exhausts is a development of Oxy-Catalyst Inc., Wayne, Pa. The device attaches to the engine exhaust manifold and burns by catalytic action the fumes in the exhaust gases from the engine.

FIBERGLAS CLAMPS . . . .

. . . . that can be used in construction, plant maintenance, power generation, communication, aviation, shipping and other industries are a development of the Le Conte Plastics Co., Inc., S. Massapequa Rd., Farmingdale, N. Y. Inasmuch as the Fiberglas is a non-conductor, the clamps do not require insulation, effecting economies in cost, weight and space. They are lighter than comparable aluminum clamps, will not support combustion, have a high heat resistance and are fungus-proof and non-corrosive. A further claim is: increased service life since their flexibility gives them greater fatigue resistance.

PROCESSES

. . . . Steel wire can be electroplated in a continuous process with copper, nickel, zinc and similar metals. The wire can then be—according to The Kenmore Metals Co., Foot of 9th St., Jersey City, N. J.—cold drawn to desired size without disturbing the plating. In drawing stainless steel wire, the process eliminates the use of lead; it protects the surface during heat treatment; and doubles the drawing speed. Research is underway for applying the process to the electrocoating of aluminum.

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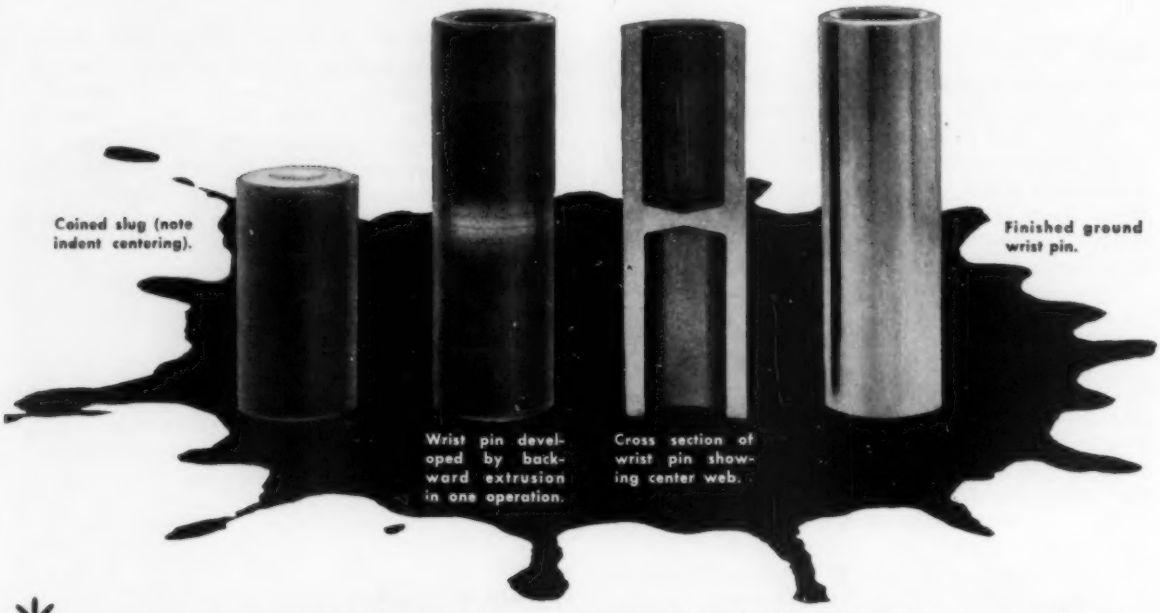
*Bonderite


Coined slug (note indent centering).
Wrist pin developed by backward extrusion in one operation.
Cross section of wrist pin showing center web.
Finished ground wrist pin.

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Highlights

DIE CASTING . . . .

. . . . of aircraft structural parts—such as landing gear wheels—are being made from aluminum base alloys by the Cleveland Aircraft Products Co., 113 E. St. Clair Ave., Cleveland, Ohio. It is reported that die casting allows stiffening webs to be incorporated which gives better rigidity and impact strength and, at the same time, reduces the weight by decreasing the section thicknesses. Wheels can also be used as cast.

CASTING . . . .

. . . . of small, intricate aluminum parts can now be made in plaster of paris molds to eliminate costly machining methods. The Casting Division of the Aluminum Company of America, 1200 Alcoa Bldg., Pittsburgh 19, Pa., reports that aluminum and magnesium parts—formerly impossible to produce by this casting method—can be turned out faster, cheaper and with such perfection as to require little or no subsequent machining.

CENTRIFUGAL COMPACTING . . . .

. . . . of powder metal parts permits greater uniformity of large parts and lower cost. The process developed by Firth Sterling Inc., McKeesport, Pa., (basic patents held by Sandrik Steel Works Co., Sweden) centrifugally forms the part under a pressure of 2 tons per sq in. Shrinkage is reported to be high, and the method cannot be used for parts having abrupt or very small changes in cross section. Also, only the heavy metal powders can be used.

BRAZING OF STAINLESS. . . .

. . . . Steel can be done in a standard furnace when provided with a controlled atmosphere, according to the General Electric Co., Ltd., Magnet House, Kingsway, London W.C.2, England. The process is reported to be suitable for copper-brazing stainless steel or for brazing when using Nicrobraz alloys as filler metal. Temperature varies between 700 to 1,180 C depending on the filler metal. Holding time at temperature is about 10 min for most filler metals, about 30 min when Nicrobraz is used.

NEW PROCESS. . . .

. . . . for the prod··ction of hydrazine, important as rocket fuel and for many other uses, is in experimental stages. Scientists at Ohio State University, North High Street, Columbus, Ohio, report that the new technique uses only ammonia and chlorine as raw materials. The process also produces, as a by-product, chloramine—which has important potential uses in many organic compounds. Heat and pressure required in the operation are relatively low.

TESTING

. . . . Stainless steel alloys with improved high temperature strength are the result of investigations made by The Cornell Aeronautical Laboratory, Inc., Buffalo 21, New York for the Navy Bureau of Aeronautics. Chromium-nickel stainless steels have been modified with small additions of titanium and boron to improve high temperature strength. Varying carbon content and heat treatment also is said to improve high temperature characteristics. Alloys are now undergoing further study to determine over-all suitability for high temperature use.

ELECTRICAL FAILURE . . . .

. . . . of certain metal surfaces on wires and contacts to conduct electricity is being investigated in General Electric Research Laboratories, One River Rd., Schenectady 5, N. Y. Tiny loop of fine platinum wire to probe surface films without damaging them are used. Measurement of pressure exerted suggests type of film present; measuring voltage needed through probe to break down film and by observing probing operation gives other data.

ATOMIC BOMBARDMENT . . . .

. . . . of glass is planned in the hope that it will help to solve the mystery of its structural makeup. Owens-Illinois Glass Co., Ohio Bldg., Toledo 1, Ohio has established a fellowship at M.I.T. to carry on the research. By bombarding a sq cm of glass surface with a continuous stream of 100 billion neutrons per sec and studying the reaction, the secret of what holds glass together may be uncovered. Bombardment will be conducted at the Brookhaven Laboratory.

HYDROGEN ANALYSIS . . . .

. . . . that shows promise of being fast and accurate enough to study hydrogen samples during steel making is being tested at the Research and Development Laboratory of the U. S. Steel Corp., 525 Wm. Penn Place Bldg., Pittsburgh 30, Pa. Technique allows analysis of a sample in about 15 min by means of a thermal conductivity cell. Tolerance of the unit is plus or minus 0.12 parts per million.

RADIOACTIVE TRACER . . . .

. . . . materials, made radioactive at the Oak Ridge atomic installation are now being used by the Aluminum Corporation of America, 1200 Alcoa Bldg., Pittsburgh 19, Pa., in research studies. Tracers are being used in lubricant evaluation, corrosion resistance studies, analytical chemistry, alloy development and metal flow during the extrusion process.

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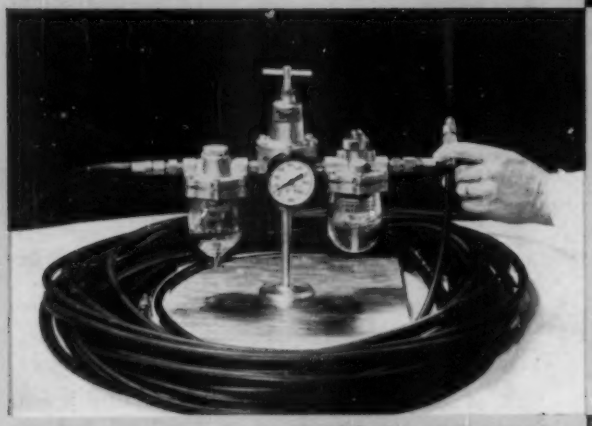

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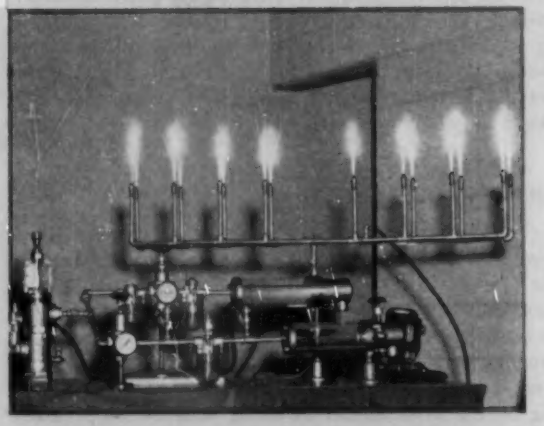

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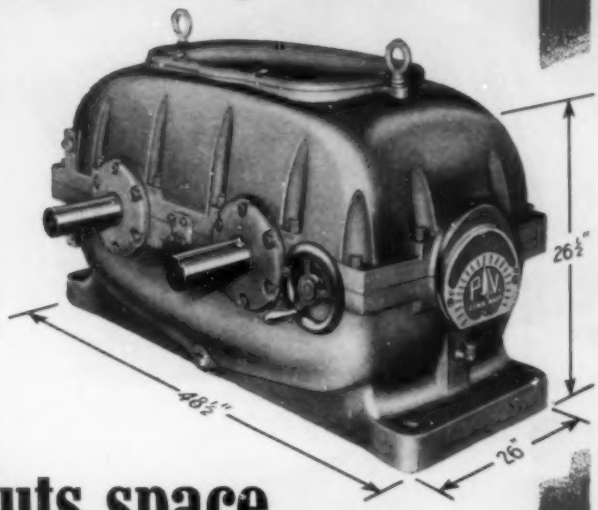

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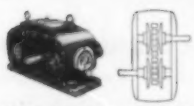
Get the facts on the Size 6 from your nearest Link-Belt office or distributor. You'll receive a copy of Folder 2374. And for information on the complete P.I.V. line, ask for Book 2274.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE 13.504

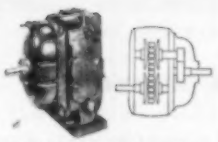
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Two Link-Belt HGG-6 P.I.V.s control the speed of reciprocating pumps. With both input and output gears, speeds range from 46.5 to 140 rpm.

4 OF 16 P.I.V. TYPES
HORIZONTAL OR VERTICAL MOUNTINGS
½ TO 25 HP—
RATIOS TO 6:1



Basic, Positive, Infinitely Variable (P.I.V.) Speed Drive.



P.I.V. with single reduction input or output helical gears.

Motorized P.I.V. with single reduction input and output helical gears.

Motorized P.I.V. with single reduction input and double reduction output helical gears.

See what adhesives are doing today!

Trimming cloth—and costs at Graflex

3M COMPANY

What you see above is a plastic-coated cloth that has just been roll-coated with a 3M adhesive, EC-880.

After this coated cloth is allowed to dry, it will be die-cut into smaller shapes and sizes for eventual use. At that time, the adhesive will be reactivated with a solvent and the trimmed piece will be pressed into permanent position on a Graflex camera case.

By roll-coating EC-880 to full sheets of this cloth, Graflex saves considerable time, material and money. Another advantage of EC-880 is its tack-free dry film. This makes it easy to handle during die-cutting operations . . . makes it a simple matter to stock an inventory of these specialized parts, too.

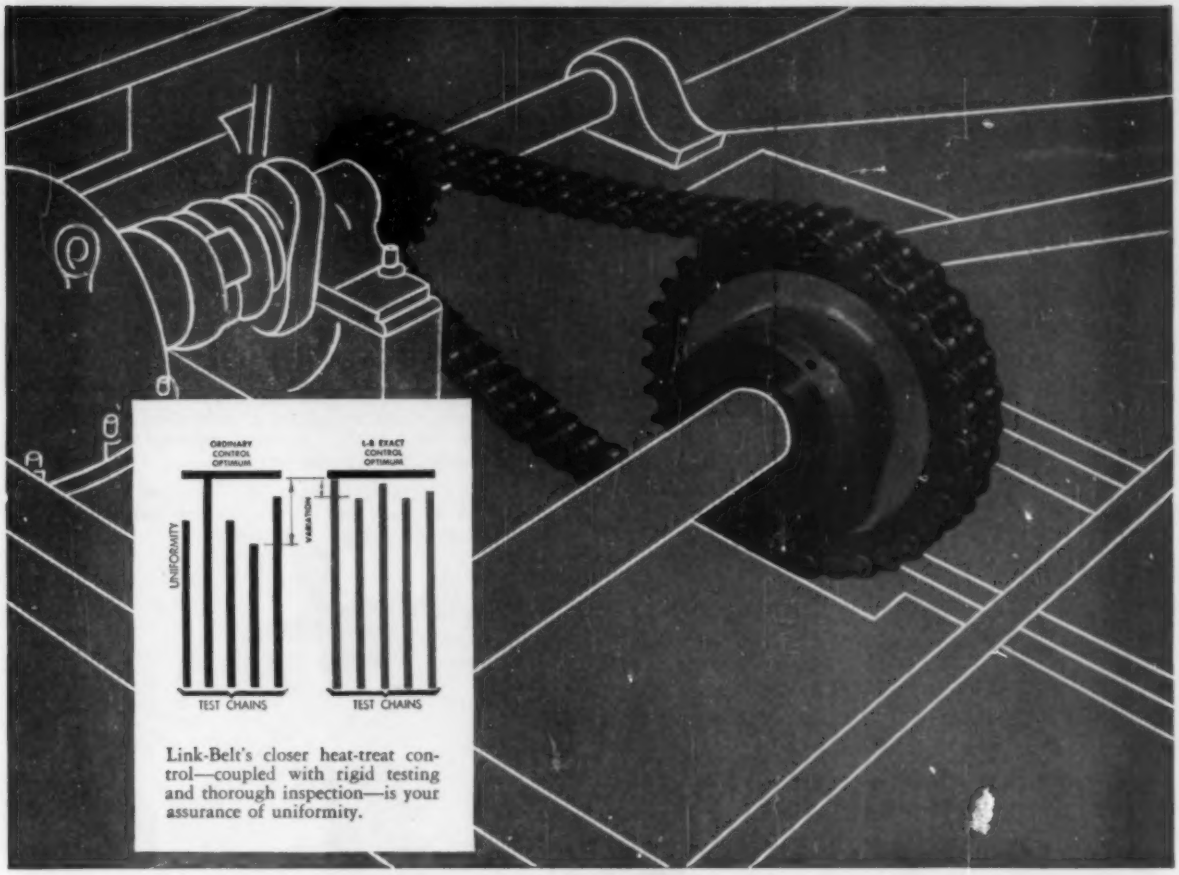
See what adhesives can do for you . . . Whatever your fastening problem—there's a 3M adhesive to help you produce more—more efficiently and economically. For details, call your 3M sales representative. Or, write today for free booklet. Address: 3M, Dept. 47, 417 Piquette Ave., Detroit 2, Mich.

see our catalog in PRODUCT DESIGN FILE or write for copy

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



Link-Belt's closer heat-treat control—coupled with rigid testing and thorough inspection—is your assurance of uniformity.

Closer heat treat control means longer roller chain life!

But it's only one of many engineering extras you get from LINK-BELT

THE long-life record of Link-Belt Precision Steel Roller Chain is based on more than closer heat treat control. Consider such extra-wear features as shot-peened rollers and lock-type bushings. They're further assurance of Link-Belt's *built-in* extra life.

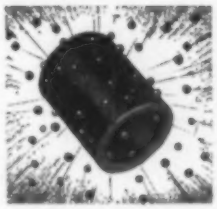
Link-Belt Roller Chain is available in single or multiple widths, ⅜″ through 3″ pitch. Double pitch, 1″ through 3″. For all the facts, call the Link-Belt office near you today, or write for Data Book No. 2457.

LINK-BELT

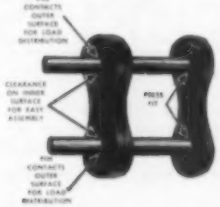
ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,100

Don't overlook these other LINK-BELT extras



Shot-peened rollers have extra fatigue life for higher speeds, heavier loads.



Couple, uncouple multiple-width chains easily.

Lock-type bushings assure free articulation.

More Muscle

FOR TOUGHEST DAILY SERVICE

FOOTE BROS. Enclosed Gear Drives

It takes plenty of muscle to meet industry's demands for sure, dependable power transmission . . . rugged design, trouble-free operation, high load-carrying capacity, top efficiency and longer life. This is the kind of service industry expects—*and gets* from Foote Bros. Enclosed Gear Drives, day after day, year in and year out.

In the famous, job-proven Foote Bros. line of enclosed gear drives, you will find a wide variety of sizes and types to meet any industrial service. See Foote Bros. *first* . . . for performance you can measure, quality you can trust.

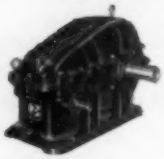
WRITE FOR COMPLETE DETAILS . . . on how Foote Bros. Enclosed Gear Drives can meet your needs for toughest daily service. Write today!

HYGRADE DRIVES
Horizontal and vertical types. Vertical available in Hytop design with long, unsupported output shaft extension. Single, helical-worm (illustrated)and double-worm reductions in ratios up to 4108 to 1; capacities up to 260 h.p.

FOOTE BROS.

Better Power Transmission Through Better Gears

Manufacturers of Duti-Rated Lifetime Gears, standard gears, enclosed gear drives of all kinds, gear motors, aircraft-quality gears and actuators, and special machinery . . . the world's finest since 1859.



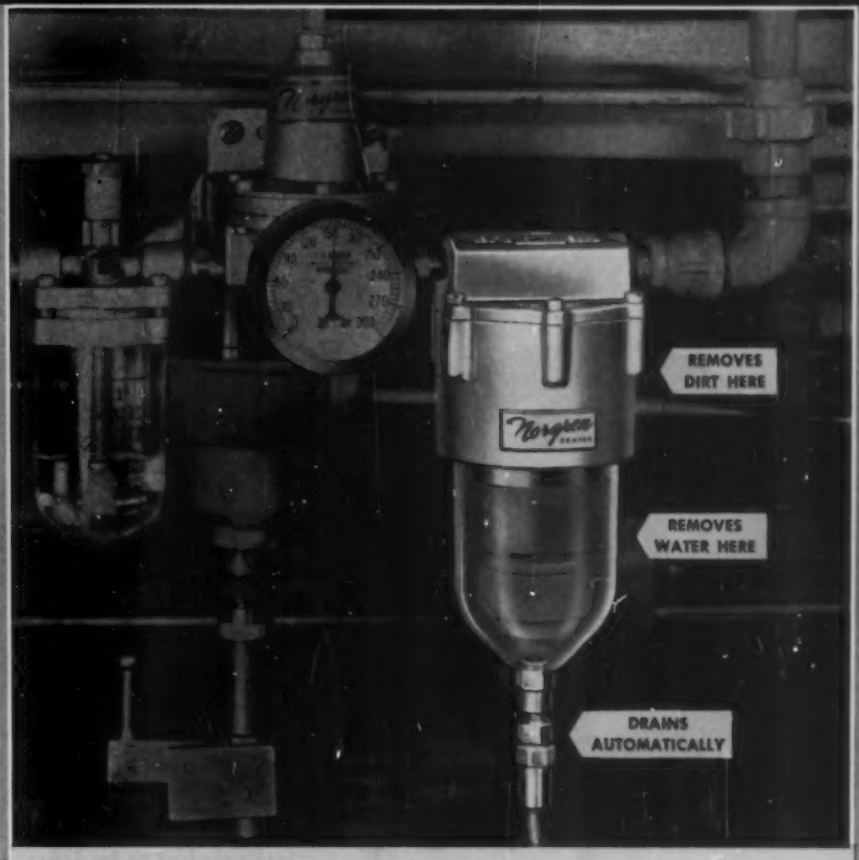
MAXI-POWER DRIVES
Compact housings, specialized heat-treatment for gearing and improved accuracy of gear tooth generation mean longer, trouble-free performance. Ratios up to 360 to 1; capacities up to 1550 h.p.

LINE-O-POWER DRIVES
Incorporate higher capacity, space saving, longer life *Duti-Rated Lifetime Gears.* Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacity range from 1 up to 200 h.p.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. I • CHICAGO 9, ILLINOIS

PROVED PROTECTION FOR AIR EQUIPMENT

with NORGREN AUTOMATIC-DRAIN FILTER



The new Norgren Automatic-Drain Filter operates automatically, whether air pressure is constant or fluctuating, whether or not air is flowing...assuring clean, dry air, without attention.

Performance data prove its efficiency—***100% water removal*** up to flow of 20 cfm, 90% at flow of 30 cfm...at 80 psi primary pressure and flow of 35 cfm ***pressure drop across filter is only 1 psi.***

WRITE FOR NEW CATALOG NO. 600

New transparent replaceable bowl filter for ¾" and 1" air lines. Water capacity 1 pint.

Replaceable metal bowl filter for ¼", ⅜" and ½" air lines.

Permanent metal bowl filter types for ¼" to 1½" air lines.

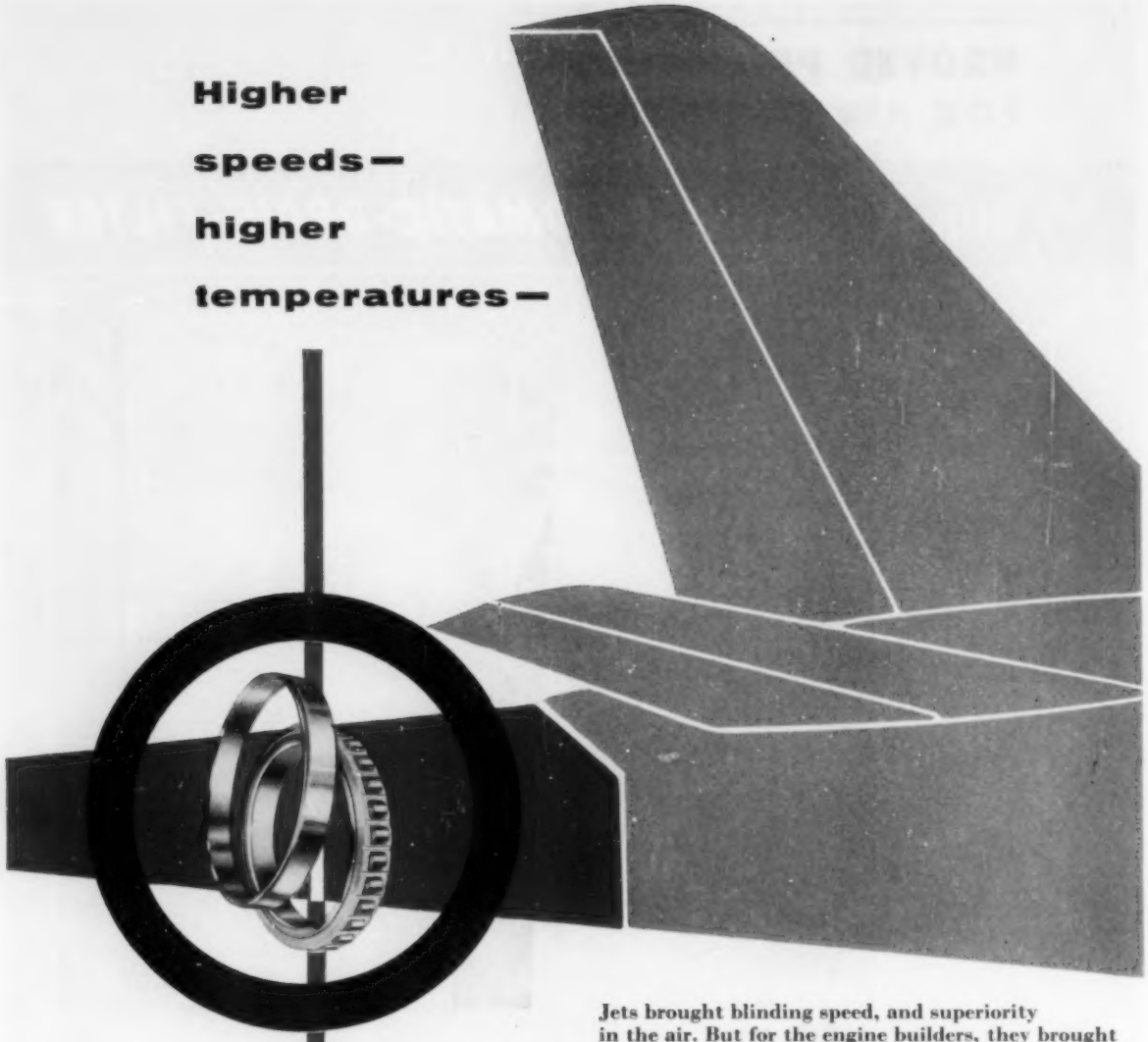
New, small replaceable bowl filter for ¼" and ⅜" air lines. Screw type clamp ring.

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

PIONEER AND LEADER IN OIL FOG LUBRICATION FOR 26 YEARS

VALVES • FILTERS • REGULATORS • LUBRICATORS • HOSE ASSEMBLIES

Higher speeds— higher temperatures—



HYATT BEARINGS!

Jets brought blinding speed, and superiority in the air. But for the engine builders, they brought problems. With higher speeds came higher operating temperatures, and engine parts, especially bearings, had to be designed to withstand destructive heat. So designers turned to Hyatt. With unexcelled research and development facilities, modern production equipment, and years of experience, Hyatt was a logical choice. Hyatt know-how assured highest quality in mass production, and since 1944 Hyatt has been a major supplier of jet bearings. When design requirements are beyond the capabilities of ordinary bearings, always call on Hyatt.

Partial list of aircraft equipped with turbo-prop and turbo-jet engines using Hyatt Bearings:

Bell X-5 Research Monoplane
Boeing XB-47C Air Force Medium Bomber
Consolidated—Vultee Model 7002 (XF-92A)
Consolidated—Vultee Turboliner
Douglas XA2D-1 "Skyshark" Navy Attack Bomber
Grumman F9F "Panther" Navy Fighter Plane
Lockheed F-80C "Shooting Star" Fighter Plane
Lockheed F-94A & B Air Force Fighter Plane
Lockheed TO-1 U.S. Navy Version of the F-80G For Use as Jet Trainer
Martin P4M-1 Long Range Navy Patrol Bomber
Martin B-57A U.S. Air Force Version of the English Electric Canberra Medium Bomber
North American AJ-1 "Savage" Navy Carrier Attack and Search Airplane
Northrop F-89A All Weather Fighter Plane
Northrop YRB-49A "Flying Wing" Heavy Bomber
Republic F84F "Thunderjet" Fighter Plane

HYATT

STRAIGHT ROLLER BARREL ROLLER TAPER ROLLER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

Here's a Fast, Smooth Operator

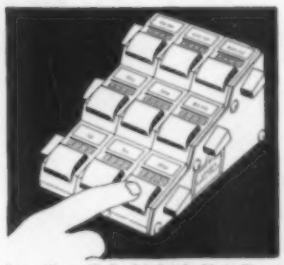
on many different jobs

Added Evidence that...

Everyone Can Count on VEEDER-ROOT

This new, high-speed direct-drive counter . . . with its one-piece "show window" case . . . was first developed for use in navigational and directional instruments. Then, because of its many adaptable features, it is eligible for employment in many other jobs. It's good for speeds up to 1800 rpm . . . temperatures from 67° to 185° F . . . and it's corrosion resistant. Drive shafts can be longer on either side or both. And base may be lengthened to take more figure-wheels if you want. All in all, a remarkably versatile performer . . . one of scores of standard and special Veeder-Root Counters for every mechanical and electrical application from Electronics to Automation. Write:

VEEDER-ROOT INCORPORATED • HARTFORD 2, CONNECTICUT



New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide. Write for news sheet and prices.

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada
Dundee, Scotland • Offices and Agents in Principal Cities

"The Name that Counts"

Now! The world's

ONAL RED

Eliminates installation

This bright colored Redicoat coating is available on any metal encased National seal. Together with the ground circumference standard on National Oil Seals, Redicoat offers the most perfect and economical metal-to-metal bore sealing available.

Figure 1. Cross section shows Redicoat seal installed in housing. Radial or circumferential scratches as deep as .003" are filled completely. Bore is sealed as Redicoat seal is installed; no drying or "setting" is required.

first pre-cemented oil seal!

ICOAT OIL SEALS

TRADE MARK

cementing—offers important economies on your production line

Now you can install press fit oil seals that insure a perfect, enduring seal between oil seal and bore as well as oil seal and shaft. You can eliminate danger of cement reaching and damaging sealing surfaces, and you can *completely eliminate cost of cementing on your production line.*

Amazing new National Redicoat is applied at NMB factories. Seals reach you pre-cemented smoothly and evenly all around the circumference of the outer case. The truly negligible additional cost of Redicoat is more than made up by your very real savings in assembly time and materials.

What is Redicoat?

National Redicoat is a material developed and applied by, and available only from, National Motor Bearing. It is dry to the touch, does not pick up dirt, and does not adhere to other seals or containers. It also prevents rust on the area covered.

Upon installation, a microscopic portion of the coating rolls up at the bore's edge (Figure 1) but the majority remains as a tough, stable cement filling all irregularities in the housing bore. Redicoat will last indefinitely even at temperatures −65° to +350° F. The fit is even more perfect than metal-to-metal with a ground outer case surface (as on all regular National seals). Seals may be removed easily, even after prolonged service at 300° F. No special preparations are needed for installation, and no tedious cleaning of the housing bore is required when Redicoat seals are removed and new seals installed.

NATIONAL OIL & GREASE SEALS O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, Calif.
Plants: Redwood City, Calif.; Van Wert, Ohio

NATIONAL MOTOR BEARING CO., INC., Dept. A
Broadway at National, Redwood City, California

Gentlemen: Please send information on Redicoat Oil Seals as applied to _____ (Type of Product)

Name _____

Company _____

Street _____

City _____ Zone _____ State _____

For finest commercial air conditioning, BUSH powers with

HOOVER

FOR CUSTOM ENGINEERING...

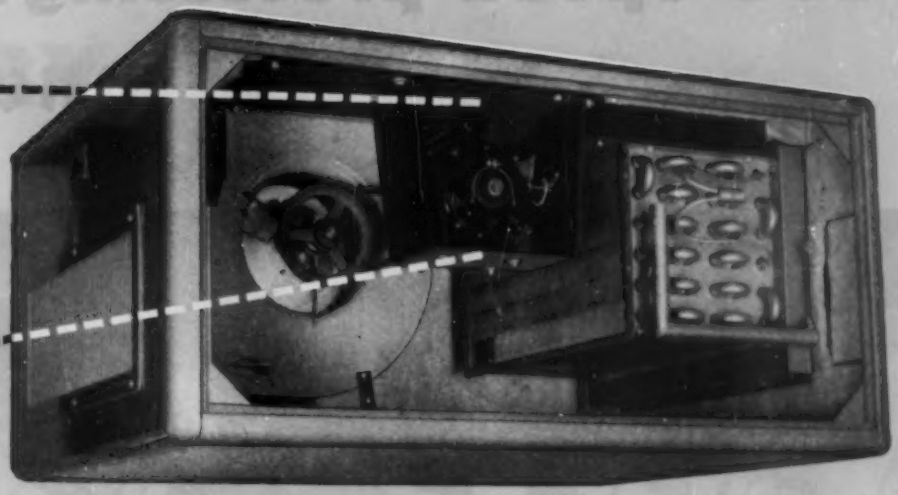
You know Bush Comfort Conditioners for their unique ceiling mount... for the practical 2-way discharge grill... for many special features built into every unit for extra economy and smartest appearance. Hoover engineers, for many years, have worked closely with Bush engineers, custom-designing motors for all types of commercial installations. According to Bush Manufacturing Company, Hoover has contributed immeasurably to the styling, efficiency and easy maintenance of their Comfort Conditioners.

FOR DEPENDABLE SUPPLY...

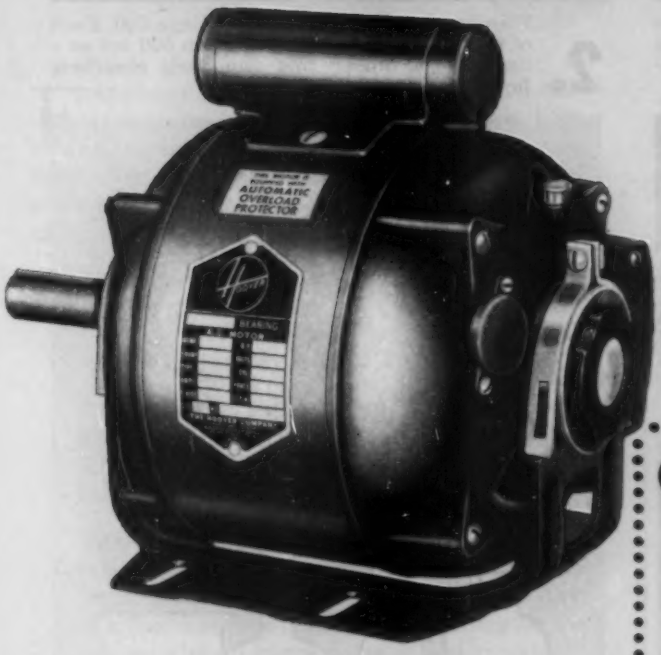
Bush's seasonal demands require prompt delivery and certain coordination with urgent production schedules. Hoover flexibility allows it. Hoover can devote plenty of engineering and production capacity to each type and model air conditioning motor. And Hoover can meet the need for special mechanical and electrical details—for experimental models, for emergency requirements, for regular or extra production runs—and ship on short notice to this prominent Connecticut firm.

FOR WORLD-WIDE SERVICE...

Bush Comfort Conditioners have become famous for reliable and continuous operation—and motor dependability has been a vital factor. Hoover-powered Bush products have remarkable records under the most adverse operating conditions. And whenever any trouble has occurred, Hoover Service Agencies have made adjustments and restored operation in shortest possible time. Hoover service stands behind every Hoover-powered unit protecting the manufacturer's reputation as well as the Hoover name.



MOTORS



PRODUCTION FOR HOME AND DEFENSE
Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

If you manufacture any product requiring fractional or integral horsepower electric motors—up to 5 h.p.—check with Hoover before you make your final decision. Hoover supplies a long list of standard-size "in-production" models for industrial and commercial equipment. Or Hoover engineers can work with your engineers to develop any special mechanical or electrical details—at lowest possible cost. (You'll find Hoover saves money, too, in installation, operation and maintenance expense!)

THE HOOVER COMPANY, ELECTRIC MOTOR DIVISION
91 BROOK AVENUE, NORTH PLAINFIELD, N. J.

Please send me further information on Hoover Motors. I am particularly interested in motors for

_____
(Indicate type of equipment)

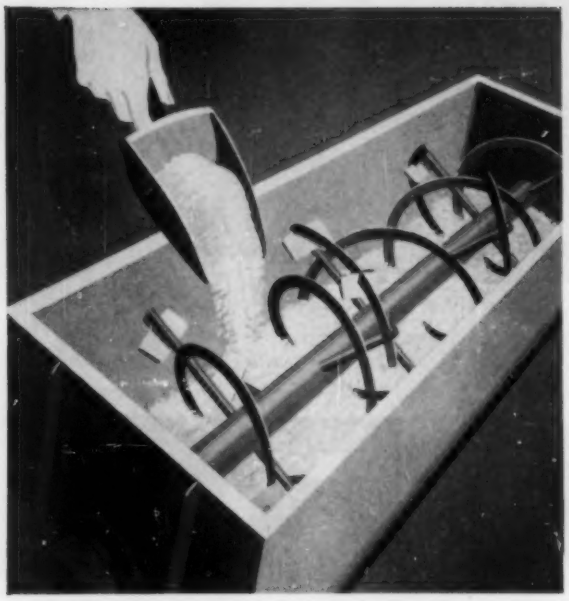
Name_____

Company_____

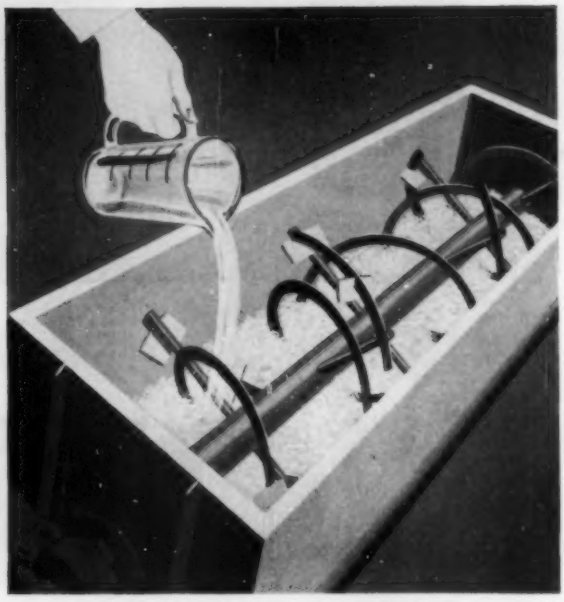
Address_____

City_____ Zone____ State_____

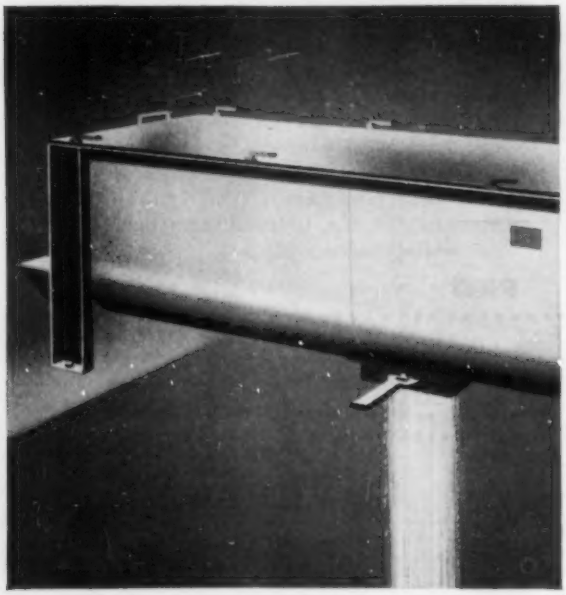
NOW! Speed processing... with Firestone's



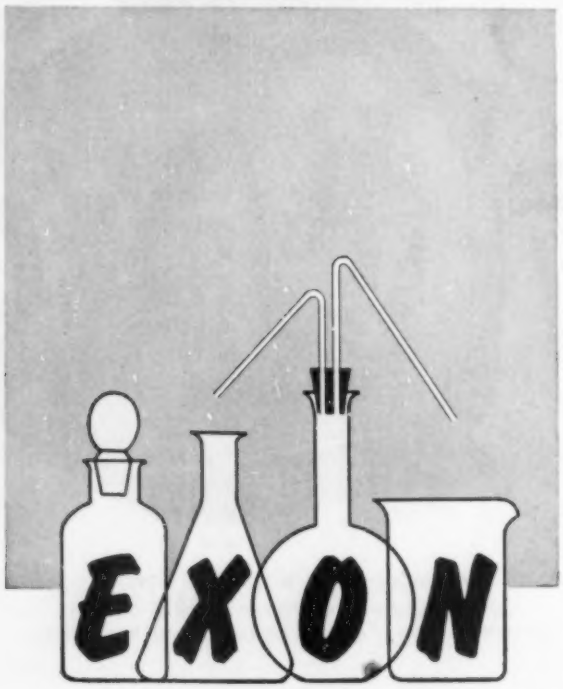
1. In preparing a sample formulation, picture shows Exon 500 resin as it is shipped by Firestone. It is in white powder form—has excellent dry blending characteristics.



2. Blending liquid plasticizer with Exon 500. Each of the controlled particles of Exon 500 act as a tiny sponge, quickly and completely absorbing liquid ingredients.



3. Result! A complete Exon 500 resin compound ready for the hopper. The formulation is free-flowing, lump free. Milling and pelletizing is never necessary.



reduce costs...
DRY BLEND resin...

EXON 500

FIRESTONE is now serving the extrusion industry with an improved EXON 500 resin. Wire and cable manufacturers in particular can avail themselves of a faster, more economical operation, a simplified, flexible inventory — through the use of Exon 500.

EXON 500 has been improved to impart excellent dry blending characteristics to compounds —without compromising its outstanding physical and electrical properties.

EXON 500 speeds blending cycles. It readily absorbs plasticizer in a fast, uniform manner. The controlled particles inherently assure the flowability of the final formulation.

EXON 500 — when used as a dry blending resin in compounding, eliminates the need for milling and pelletizing. Finished formulation is a fluid-like, free-flowing powder ready for the hopper with no lumps, cakes or agglomerates.

EXON 500 simplifies and decreases inventory by allowing the processor a greater flexibility of operation.

Complete details for the use of Exon 500 resin in electrical and mechanical compounds—plus suggestions and technical assistance in their development are available on request.

PROPERTIES OF EXON 500

Physical Properties

Form	White Powder
Specific Gravity	1.40
Average Bulking Density, gm./c.c.	0.50
Average Relative Viscosity	2.55

Approximate Electrical Properties

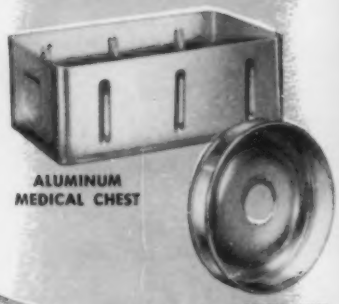
Insulation Resistance (*15.6°C*) (*Megohms/1000 ft.*)	4500
Dielectric Constant (*23°C*) (*SIC—one day*)	7
Dielectric Strength, KV. (*in oil at 23°C*)	35-37
Power Factor (*60 cycles at 23°C*)	0.099-0.100

CHEMICAL SALES DIVISION

Firestone Plastics Company, Pottstown, Pa., Dept. 6C
Division of The Firestone Tire & Rubber Co.

From Tumblers to Trailers..

ALUMINUM PITCHER AND TUMBLER



ALUMINUM MEDICAL CHEST

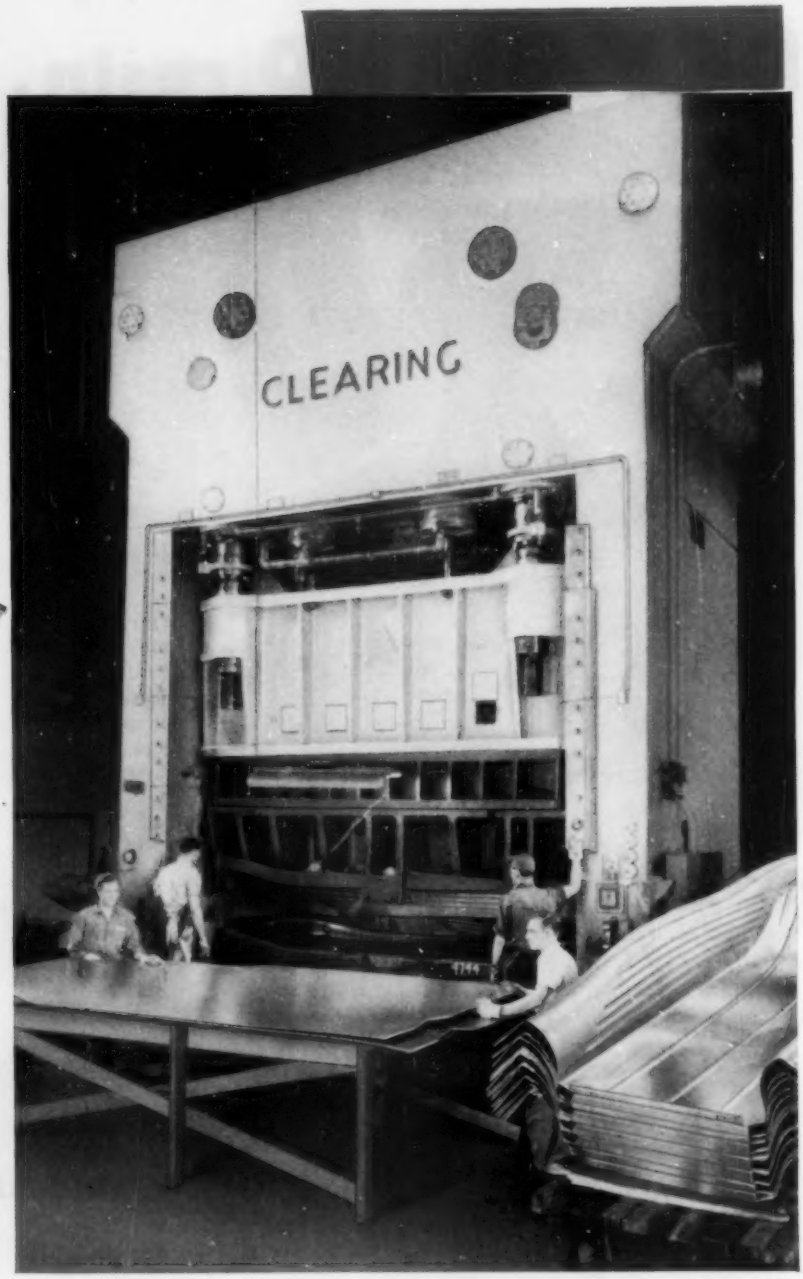
ALUMINUM TRAILER WHEEL

ALUMINUM TRAILER CROSS MEMBER

ALUMINUM WASHER AND DRYER TUBS

ALUMINUM DEEP WELL COOKER

These aluminum blanks are ready to go to a manufacturer. Scrap beside press is remelted at Reynolds. Users save an average of 30% scrap loss, eliminate scrap handling expense.



Photograph shows 1700-ton hydraulic press in operation at a Reynolds plant. Work in progress is one of the largest drawn aluminum parts ever made—a one-piece 12' x 4'8" hull for an aluminum boat. This press is currently producing other drawn parts 6' in diameter.

REYNOLDS ALUMINUM.

BLANKING · EMBOSSING · STAMPING · DRAWING RIVETING · FORMING

.Get the Most From Your Designs with

ALUMINUM Press Parts from Reynolds

Shown here is a "giant's handful" of Reynolds presses along with typical aluminum parts produced on these presses by Reynolds Aluminum Fabricating Service. In *two plants alone,* out of the more than 30 Reynolds plants in 18 states, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

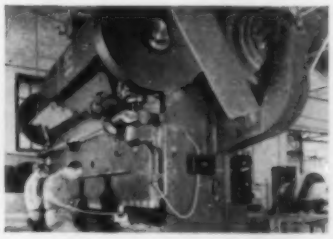
If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing, or other press operations, call on Reynolds to produce these parts to your specifications. The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

For full details, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write direct to Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.

Write for your free copy of the new 24-page Reynolds "Catalog of Facilities."

See "Mr. Peepers", starring Wally Cox, Sundays on NBC-TV.

Here is part of a battery of medium presses in a Reynolds plant. Large, medium or small —Reynolds Aluminum Fabricating Service has presses to fit your every need.



This 12', 300-ton press brake handles thick aluminum plate. Press brakes from 22½ tons are available for your requirements by Reynolds Aluminum Fabricating Service.

Small presses, too, are available in Reynolds plants to assure speedy delivery of high quality parts produced to your specifications by Reynolds Aluminum Fabricating Service.

FABRICATING SERVICE

ROLL SHAPING · TUBE BENDING · WELDING · BRAZING · FINISHING

Arthur Marquis
Design and Application Engineer

Arthur R. Kozlowski
Design and Application Engineer

John H. Smedley
Design and Application Engineer

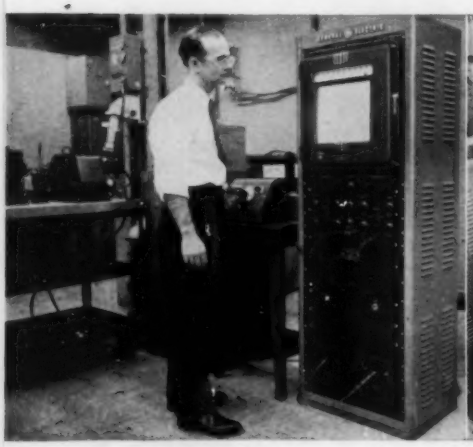
George D. Barcus
Design Engineer

Rollin J. Parker
Supervisor—Magnetic Products Design and Application

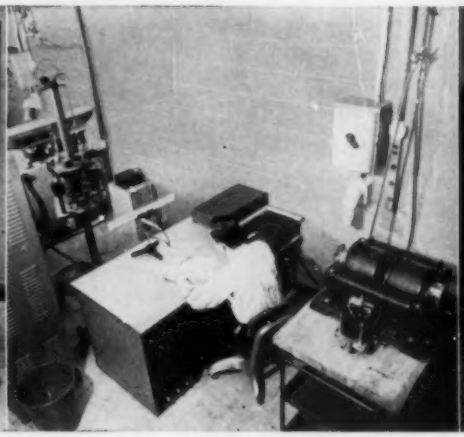
These Carboloy® permanent

At the modern Carboloy magnet laboratory, in Detroit, trained engineers work with the finest equipment. Where necessary, special instruments are often designed by the engineers.

With such complete facilities, Carboloy magnet engineers can give you accurate information, quickly. And, they can thoroughly test their designs and the performance of the magnets in your products.



DC Recording Hysteresigraph. Simultaneously plots magnetic force and resulting magnetic induction. Produces complete hysteresis loops, not ordinary point-by-point readings.



High H-Permeameter. Provides point-by-point readings of magnetizing force and induction. Control table and Ballistic Galvanometer also used for general flux measurements.

Condenser Discharge Magnetizer. Produces very large current impulse for magnetizing magnet configurations that can best be accomplished with special field shapes.

Ernest E. George
Mgr.—Design and Application Engineering

Robert J. Studders
Supervisor—Magnetic Materials and Process Development

Edgar W. Engle
Mgr.—Product and Process Development Engineering

Edgar L. Hubbard
Sales Mgr.—Permanent Magnets

magnet engineers can help improve products, cut costs

Experienced magnet engineers, using the latest test and development equipment, will provide complete engineering appraisal service

You can get valuable technical assistance, without obligation, on the design and application of permanent magnets, from Carboloy magnet engineers . . . men who are leaders in the field.

Only at the Carboloy Department can you obtain engineering appraisal service and sample magnets from separate laboratory facilities devoted exclusively to helping you determine the design and optimum size, shape and strength magnets to fit your particular application. Your product will be tested in the modern Carboloy magnet laboratories, on the latest test instruments, to assure the maximum operating efficiency of the magnets.

PROVED RESULTS

The assistance Carboloy engineers have given other designers and manufacturers has paid off time and again in lower production costs, improved product efficiency, simplified assemblies and reduced product size.

You can rely on their solutions because these engineers, many of whom worked on the original development of Alnico, are specially trained and experienced in all phases of permanent magnet design and application.

You can depend on Carboloy magnet sales engineers, too, for authoritative and intelligent answers to your questions. These men have intensive, special training in permanent magnets, supporting their engineering and technical backgrounds.

A COMPLETE SERVICE

Together with the engineers who are working on the development of new magnetic materials and on the improvement of existing Alnico grades, *these men make a complete permanent magnet team.* Their sole job is to help you utilize the tremendous potential of permanent magnets for new and improved products.

This team can start working for you, today. Just fill out the coupon and attach to it your company letterhead, and where possible, blueprints or sketches of the job. Or, if you prefer, the coupon will bring a call by your local Carboloy magnet sales engineer.

Three typical, successful appraisal projects:

INSTRUMENTS. Working with Thomas A. Edison, Inc., Carboloy engineers provided the magnet design that made possible a revolutionary fire detection relay. Use of the proper magnets simplified the design of the relay and reduced its size and weight.

CONTROLS. The development of the hysteresis brake was pioneered by Carboloy magnet engineers. Now widely used in the textile and wire rope industries, this brake eliminates friction, while maintaining the necessary constant tension.

TELEVISION. Carboloy magnet engineers collaborated with tube engineers on the design of a new magnetic internal focusing device. They designed the smaller, more efficient magnets that helped eliminate focusing dials and external assemblies.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY
Department of General Electric Company
11127 E. 8 Mile Road, Detroit 32, Michigan

☐ I would like magnet engineering assistance; I am enclosing necessary information and blueprints.

☐ Have a Carboloy magnet salesman call.

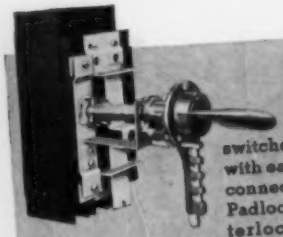
Name _____ Position _____

Company _____

Address _____

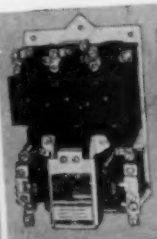
City _____ Zone ____ State _____

IT TAKES ALL 3 for



DISCONNECTS

Heavy duty industrial switches or circuit breakers, with easily installed safety disconnect handle mechanisms. Padlocking provision, and interlocking with door, safeguard personnel.

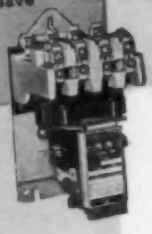


MOTOR STARTERS

Known throughout industry for maximum reliability and accessibility. Easily attached electrical interlocks save space and cost of separate relays.

CONTROL RELAYS

Compact without sacrifice of accessibility, wiring ease or reliability. 2 to 8 poles, convertible from normally open to closed.



TIMING RELAYS

Accurately timed delay periods assure proper machine sequencing. Rugged pneumatic timers give consistent performance over several millions of operations.

1 a COMPLETE line of components . . .

You can meet virtually any AC or DC application need by using standard Square D components. Each is designed to perform a specific control function—in minimum space—with maximum accessibility for easy inspection and maintenance. Each is physically proportioned for efficient and compact combination with other Square D components in building better, more attractive control panels.

CONTROL CIRCUIT TRANSFORMERS

Good transformer regulation maintains stable secondary voltage, even when energizing large solenoids or magnetic devices. New sizes extend range to 1000 VA.

PRESSURE SWITCHES

Adjustable pressure ranges from 1 to 3000 P. S. I. Drip-tight, oil-resistant enclosure houses sturdy mechanism and S. P. D. T. electrical contacts.

PUSHBUTTONS & ENCLOSURES

Heavy duty, oil-tight pushbuttons, selector switches and pilot lights in attractive cast enclosures harmonize with machine contours.

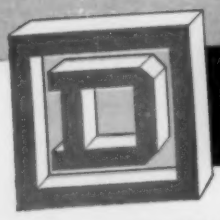
LIMIT SWITCHES

Compact enclosures exclude oil and dust. Easily adjustable operating arms and accessible terminals simplify installation.

DRUM SWITCHES

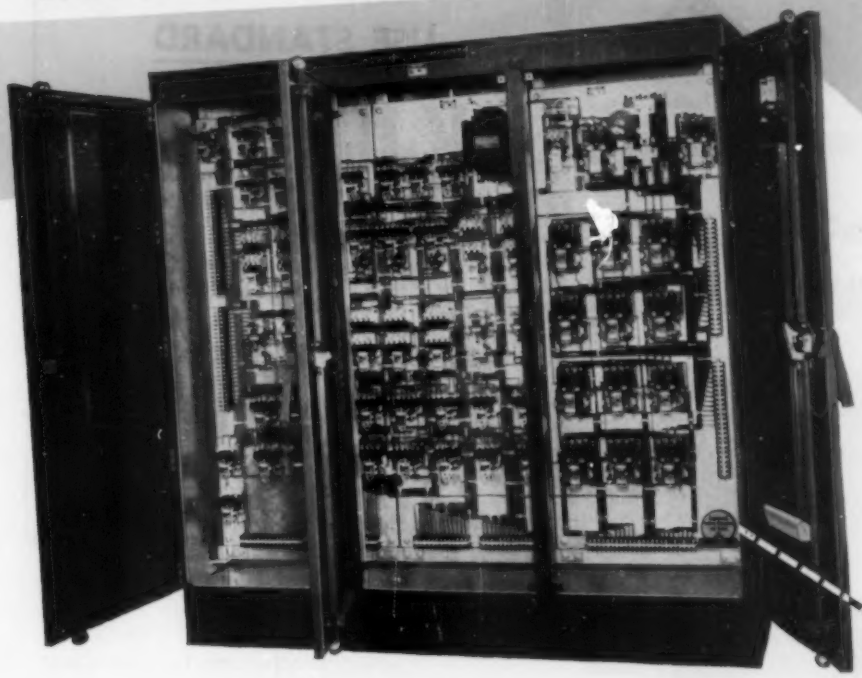
Attractively styled, compact case enhances appearance of machine. Switch is easily convertible from maintained contact to spring return.

NEW!



SQUARE D COMPANY

DESIGN LEADERSHIP IN MACHINE TOOL CONTROL



Engineered, Factory-Assembled and Tested by SQUARE D COMPANY

2 Field Engineering . . .

Through seasoned Field Engineers, headquartered in more than 50 principal cities, Square D works "hand-in-glove" with machinery builders and plant engineers in solving electrical control problems. You'll like to work with them. They talk your language. They're backed by thorough factory engineering to assure the best possible selection of circuits and components.

3 Factory Assembly and Test . . .

No other electrical control manufacturer offers such complete and flexible facilities for designing and building custom equipment. If you don't have the complete story of Square D's new Job Shop operation, mail the coupon and we'll send it to you promptly.

SQUARE D COMPANY, Dept. 86
4041 N. Richards Street, Milwaukee 12, Wis.

Please send me a copy of your new booklet which gives the complete story of Square D's new **JOB SHOP OPERATION.**

Name _____

Address _____

City _____ Zone _____ State _____

Here's How to Solve Your Temperature Control Problems . . .

USE STANDARD

KLIXON

Thermo Snap®

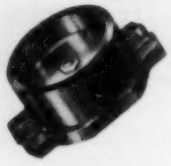
CONTROLS

C4344
Hermetically Sealed

C4320
Exposed Disc

C4391
Hermetically Sealed

C4370
Enclosed Disc



A-1" and SA-½" Series

C4371
Immersion Type

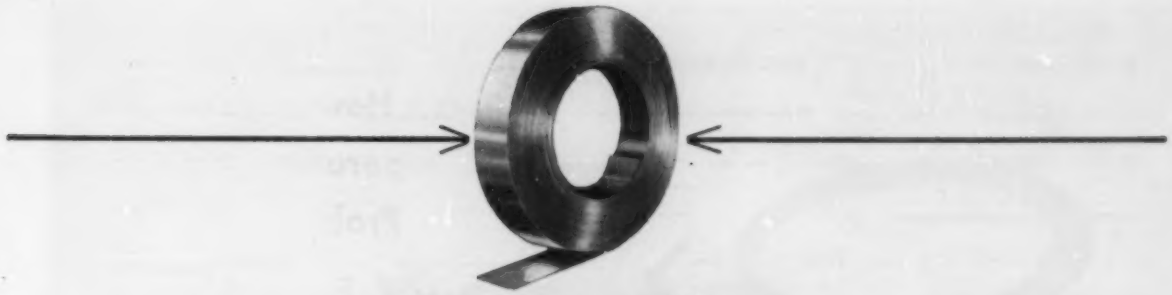
KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
907 FOREST STREET, ATTLEBORO, MASS.

Designers and manufacturers seeking accuracy and efficiency in temperature control rely more and more on *standard* Klixon Thermo-Snap Controls.

Actuated by the Spencer snap-action thermostatic disc, they snap open with a quick clean break . . . close to a solid make . . . always provide accurate control in every application whether it be in civilian or military products. Small and compact, they fit into products without complicated design or alterations. And because you can usually use *standard* Klixon Thermo-Snap Controls to do the job, you save money by eliminating special thermostat design.

Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges. Write for complete information, today.



Conversion from Copper to ALCUPLATE® can Reduce Your Cost up to 30%

What is ALCUPLATE?

ALCUPLATE is a solid layer of copper permanently clad on one side or both sides of less expensive aluminum.

This gives you solid copper performance at a lower cost over solid copper.

In addition to its lower cost, ALCUPLATE has virtually the same physical and electrical properties as pure copper. This permits fabrication of many parts and products from ALCUPLATE at savings of from 15%–30% over solid copper.

Can ALCUPLATE be worked?

ALCUPLATE can be fabricated by stamping, drawing, spinning and forming. The copper provides an ideal surface for soft-soldering operations and electroplated or other finishes.

In what sizes is ALCUPLATE stock available?

In coils or flat stock up to 1/16″ thick x 13″ wide and in a choice of thickness ratios and tempers.

ALCUPLATE FEATURES:

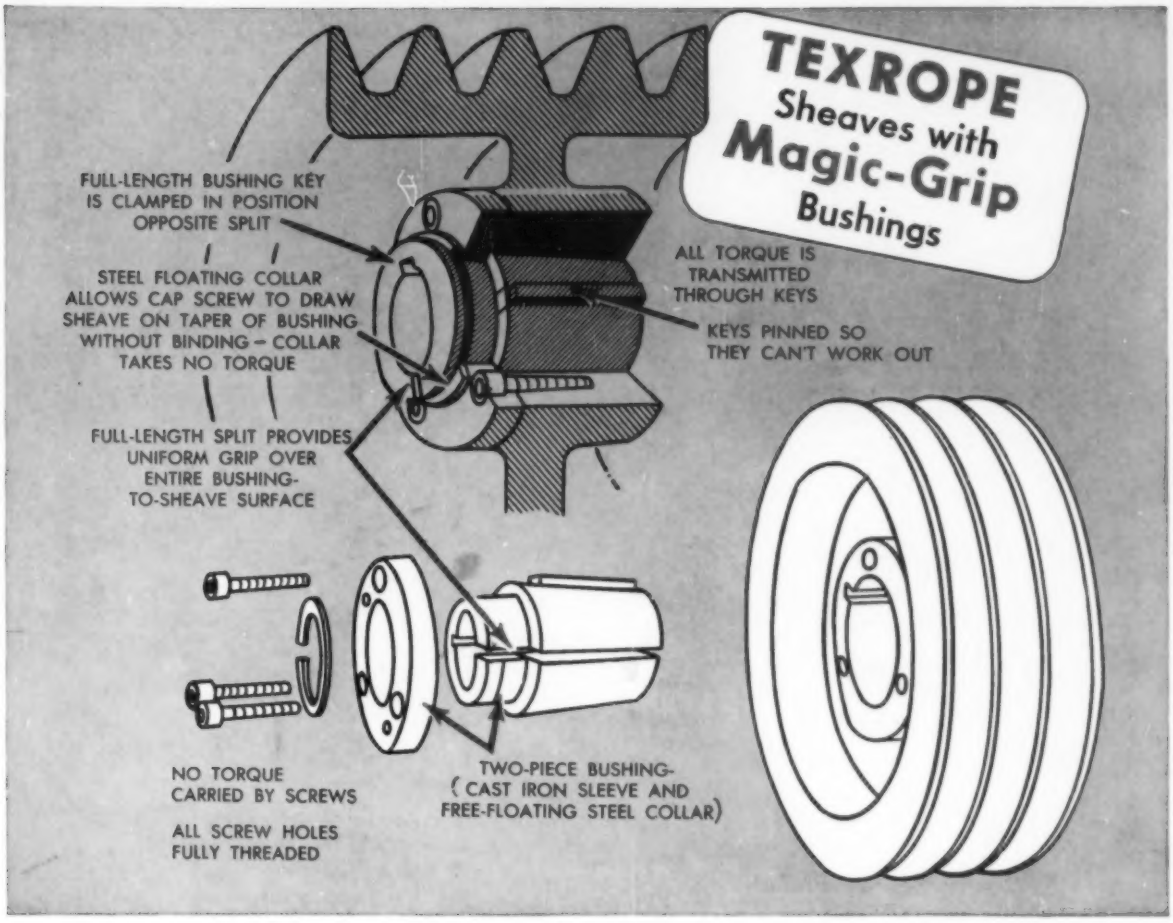
- Natural copper appearance
- High electrical conductivity
- Excellent heat dissipation
- Soft-soldering surfaces
- Easy fabrication
- Light weight

ALCUPLATE®

For further information, write or wire

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
17 FOREST STREET, ATTLEBORO, MASS.

DO SMALL PARTS
LOOM LARGE
in your product's performance?
If the performance of your products depends on the concentricity of a small pin...on the perfection of a pivot or roller or other small precision part, let Torrington make those parts for you.
As a leading contract fabricator we produce over 10 million pieces a day to customers' specifications of tolerance, finish, temper and hardness—for less than you can make them yourself. Why not get our quotation?
More details in our Condensed Catalog—write for your copy today. And don't forget to send a sample part or blueprint for our quotation. It can save you time and money.
THE TORRINGTON COMPANY
Specialties Division
23C Field Street, Torrington, Conn.
TORRINGTON SPECIAL METAL PARTS
Makers of Torrington Needle Bearings


TEXROPE
Sheaves with
Magic-Grip
Bushings
FULL-LENGTH BUSHING KEY IS CLAMPED IN POSITION OPPOSITE SPLIT
STEEL FLOATING COLLAR ALLOWS CAP SCREW TO DRAW SHEAVE ON TAPER OF BUSHING WITHOUT BINDING – COLLAR TAKES NO TORQUE
FULL-LENGTH SPLIT PROVIDES UNIFORM GRIP OVER ENTIRE BUSHING-TO-SHEAVE SURFACE
ALL TORQUE IS TRANSMITTED THROUGH KEYS
KEYS PINNED SO THEY CAN'T WORK OUT
NO TORQUE CARRIED BY SCREWS
ALL SCREW HOLES FULLY THREADED
TWO-PIECE BUSHING- (CAST IRON SLEEVE AND FREE-FLOATING STEEL COLLAR)

Get the Only Sheave with ALL the Most Needed Features

Here's Comparison of *Magic-Grip* Sheave and Other Sheaves

	Magic-Grip Sheaves	SHEAVE A	SHEAVE B	SHEAVE C
Bushing fully split for uniform clamping action.	Yes	Yes	No	Yes
Load carried by keys instead of threaded bolts.	Yes	No	No	No
Bushings cover full range of NEMA "probable" shaft diameters.	Yes	Yes	Yes	No
All screws engage full thread.	Yes	Yes	Yes	No
Mounts in one piece.	Yes	No	Yes	Yes
Squares itself with shaft.	Yes	No	No	No

A-4167

Texrope and *Magic-Grip* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

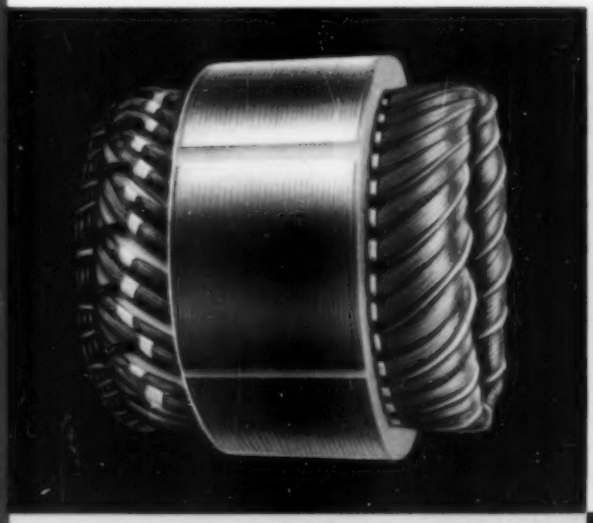
Get Greater
with New Features

Motor Economy
. . . Proved Principles

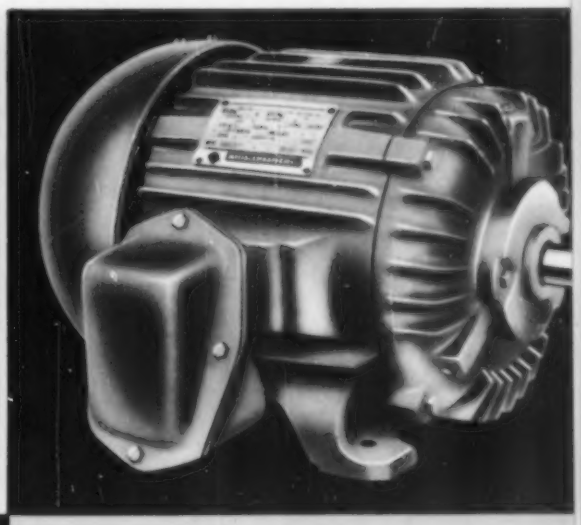
Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous design, it retains the easy-to-clean, fin-type construction which Allis-Chalmers pioneered several years ago. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.



STATOR DOUBLE INSULATED —Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.



FIN-TYPE CAST-IRON FRAME — Proved by years of service. Cooling ribs are cast integrally with the yoke; air is blown over them without restriction. There are no enclosed external air passages to clog up with dirt and thereby ruin cooling efficiency. Radiating surface provides reserve cooling capacity for extra strenuous duty. Cleaning, if required, is a few moments work with an air hose, brush or vacuum cleaner.

Multiple bearing protection keeps grease in... keeps dirt out...permits relubrication in service

Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4363

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

we sell ALLIS-CHALMERS CONTROL

we give ENGINEERING HELP

Contact Your Nearby Allis-Chalmers Representative

The time to call on your Allis-Chalmers field engineer is when your equipment design is in the drafting board stage. Your A-C representative is an application specialist — ready and able to work with your staff to determine your control needs. His suggestions and analyses are backed by Allis-Chalmers engineering departments . . . by the experience gained in solving thousands of control problems . . . by complete research and testing facilities.

Pictured here are just a few of the many Allis-Chalmers control devices . . . standard, modified standard, and especially designed equipment. Each is recommended and applied with personal, expert attention to your particular problem . . . to assure top operating efficiency of your equipment. Get all the facts on Allis-Chalmers control plus application assistance. Write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4053

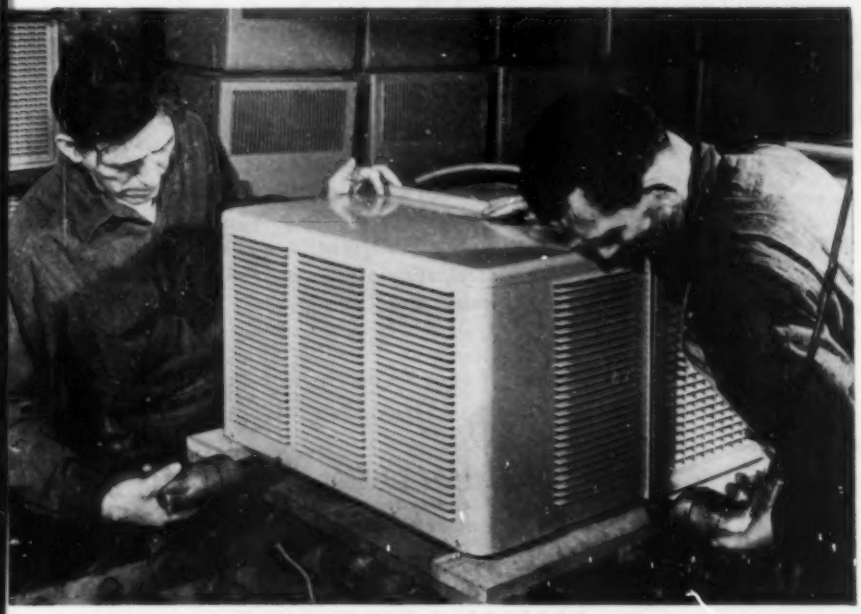
Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Users praise Phillips Cross-Recessed-Head Screws

ALUMINUM "FLEETLITE" WINDOWS, product of Fleet of America, Inc., give maximum protection against wind, rain, dust, and heat. They owe much of the rigidity of their sash construction to reinforced sash corner angles. "Use of Phillips screws," says Stephen R. Solar, plant manager, "has rewarded us with increased production, ease of operation and longer tool life." Benedict Turner, Jr. here drives a Phillips screw into an angle bracket.

APEX ELECTRICAL MANUFACTURING COMPANY'S Superintendent of Assembly, William A. Haverlock, says, "Our usage of Phillips screws has constantly increased. We have been replacing slotted types with the easier-to-use Phillips wherever the application permits. We simply cannot afford the damage to the finish of our units with slippage of the driver in slotted type screws." Above, John Champa fastens shroud in place.



PHILLIPS SCREWS ARE USED EXCLUSIVELY ON FEDDERS AIR CONDITIONERS. "There have been times," said Raymond Angiel, plant foreman, "when we have exhausted our supply of Phillips screws and had to turn to ordinary screws. We then had to put *additional* men on the production line to achieve the same level of completed units. Phillips screws can be inserted with greater speed, are easier to drive."

• MANUFACTURERS OF • PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY

... AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.

for those
"HARD-TO-REACH"
Places!

Lamson PLUG NUTS

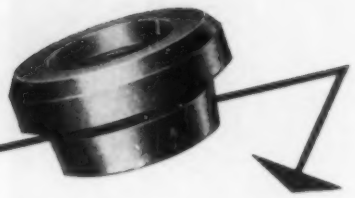
The advantages of Plug Nuts are many-fold. Both the designer and the production man will find they can solve many special fastening problems that cannot be solved in any other way.

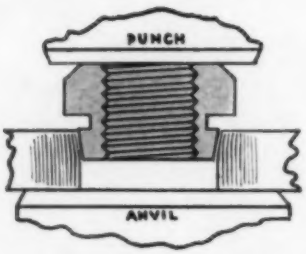
For instance, Plug Nuts are the ideal solution to "one way" fastening where it is difficult or impossible to work from both sides of the assembly.

Plug Nuts can often eliminate or simplify machining operations, improve the product, simplify design or reduce assembly, and hence, labor costs.

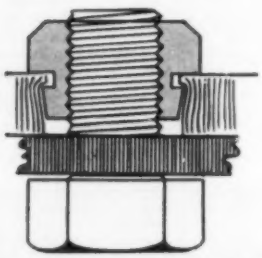
If you have an application where you think you might use Plug Nuts, send us the size required, or details of the application, and we'll be happy to send sample nuts for trial.

For additional detailed information send for the Lamson Plug Nut Brochure.





SEATING PLUG NUT IN HOLE



PLUG NUT SEATED AND BOLT TIGHTENED DOWN

PLUG NUT SIZES AND TYPES

Plug Nuts are available in sizes ranging from #4 to ½" diameter—fine or coarse threads. Plug Nuts work in copper, brass, magnesium, aluminum, steel, alloy steel castings (die and sand) and forgings.

U. S. PATENT NO. 2490594

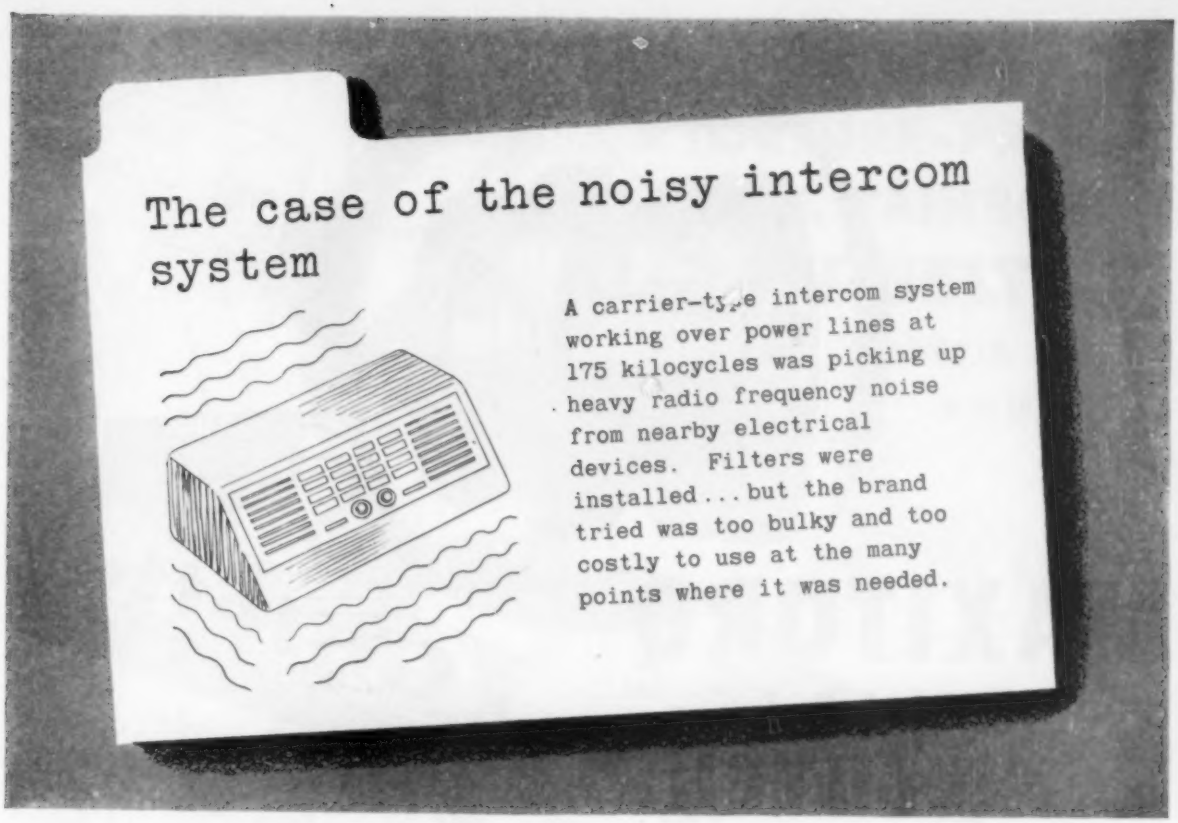
HAVE ONE (or more) ON US!

Send us the details on any application where you think you could use Plug Nuts and we'll send you sample nuts to try out. No obligation, of course.

Lamson & Sessions

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

The facilities of our company are at your disposal to assist you with any fastener problem.


The case of the noisy intercom system
A carrier-type intercom system working over power lines at 175 kilocycles was picking up heavy radio frequency noise from nearby electrical devices. Filters were installed... but the brand tried was too bulky and too costly to use at the many points where it was needed.

SOLVED by Mallory Noise Filters

Mallory engineers worked out a simple Z-type band-suppression filter that effectively attenuates the 175-kilocycle noise and carries up to 100 watts. Only 1⅜ inches in diameter and three inches high, the unit simply plugs into the power receptacle; needs no mounting hardware. A built-in fuse is readily accessible just by twisting the halves of the can apart. And the whole filter is supplied at an economical price.

Noise suppression engineered by Mallory can help your product avoid objectionable interference with many types of sensitive electronic equipment in military and civilian use today. Our engineers will custom-design a filter that holds noise output to specified microvolt levels over whatever frequency bands may be encountered. For a detailed analysis of your requirements, write or call us today.

Expect more . . .

Get more from **MALLORY**

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

MAXITORQ

Overload Release CLUTCH

minimizes machine Down-Time

AT THE
GILLETTE SAFETY RAZOR CO.

The Maxitorq automatic Overload Release Clutch was designed especially to protect high-speed machinery, and we are gratified to have testimonials such as the following:

> "The Gillette Safety Razor Company chose the Maxitorq Overload Release Clutch to protect a section of their blade and shaving cream packaging machines against costly down-time due to unpredictable machine jams.
>
> "Over a period of a year, wrapping millions of blades per week, Maxitorq Clutches have eliminated machine down-time except in a few minor instances. Thus, more constant production has been maintained in the packaging department."

When an accidental overload occurs, the clutch automatically releases, stopping the machine, preventing damage to machine and product. When the jammed condition has been cleared, the clutch is re-engaged and the machine is again in operation. By means of a simple finger-tip adjustment, the clutch is set to transmit the normal running load.

There are six sizes, ¼ to 5 h.p. @ 100 r.p.m.; max. working torque ft. lbs. 13 to 263. Maxitorq "floating" discs prevent heating in neutral, and all assembly, take-apart, and adjustments are manual; disengagement is instant and complete. Submit your clutch problems to our engineers for practical solutions.

SEND FOR CATALOG NO. PE-7.

BCJ53

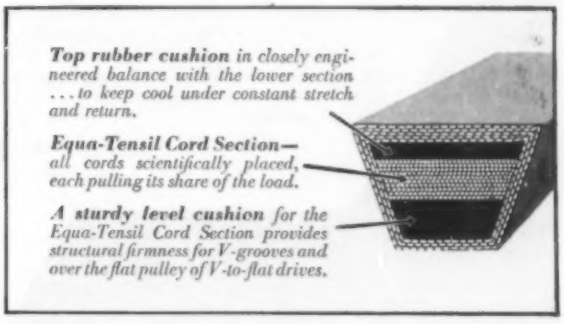
THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

SPECIAL TORTURE-PROOF U. S. RAINBOW V-BELT YAWNS AT ABUSE

If your V-belts have to withstand conditions not found on the average drive, such as oil, high temperatures, static electricity—order U. S. Rainbow® V-belts compounded to handle such rugged treatment.

- Cords are treated with latex to reduce heat generated by constant flexing, and to get maximum adhesion between the component parts of the belt.
- Straight sidewalls provide extra pulling power by gripping the grooves for complete contact the full height of the belt.
- Protective jackets keep out dirt and prolong wear.

Order from your distributor, or contact any of United States Rubber Company's 26 District Sales Offices, or write to address below.


Top rubber cushion in closely engineered balance with the lower section . . . to keep cool under constant stretch and return.
Equa-Tensil Cord Section— all cords scientifically placed, each pulling its share of the load.
A sturdy level cushion for the Equa-Tensil Cord Section provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.

A COMPLETE DRIVE SERVICE

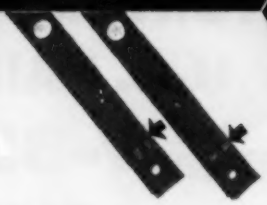
MULTIPLE V-BELTS · F. H. P. V-BELTS · SHEAVES
FLAT BELTS AND BELTING · SPECIAL PURPOSE BELTS

"U. S. Research perfects it.
"U. S." Production builds it.
U. S. Industry depends on it.

US RUBBER

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes
Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting



CROSSBAR CONTACTS FOR MINIATURE RELAYS

Originally designed for use in telephone relays, crossbar contacts are now widely used for miniature relays and contacts. Assembly is speeded and eased because alignment of contacts is not critical.

Major savings are made by attaching with Makepeace machines which cut off and weld automatically, and in the reduction of waste of precious metal. Laminated precious metal capped contact tape is produced in production runs and supplied on reels. There is no handling of individual tips.

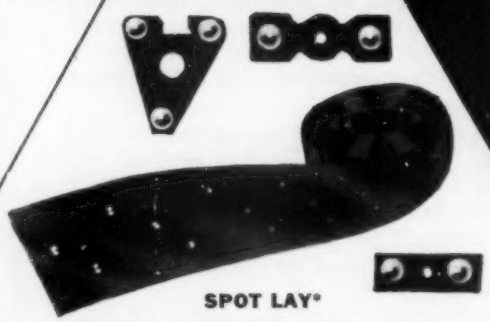
Better Electrical Contacts by

Makepeace

For more than half a century, Makepeace has specialized in and perfected the production of laminated and solid precious metals. Tolerances are held to the closest possible margins. Electrical qualities, strength, hardness and temper meet the most exacting specifications. As a result, manufacturers of electrical equipment look to Makepeace as their most dependable source of supply for materials of the highest quality and the longest service life.

RAISED LAY

When raised lay is used, costly assembly operations are reduced to blanking costs and no precious metals are wasted. That is because one or more strips of silver are bonded to a base metal in the form of a ridge or a bar. Cold, hard rolling produces the required temper in the base metal and dense hard contact surfaces for the most efficient electrical and mechanical qualities.



SPOT LAY*

Developed and perfected by Makepeace, this exclusive process brazes slugs of precious metal in strip stock, positioning them exactly where needed. This new, economical and efficient material permits manufacturers to produce rotors in switches and small bridge contacts at lower costs and with improved life performance.

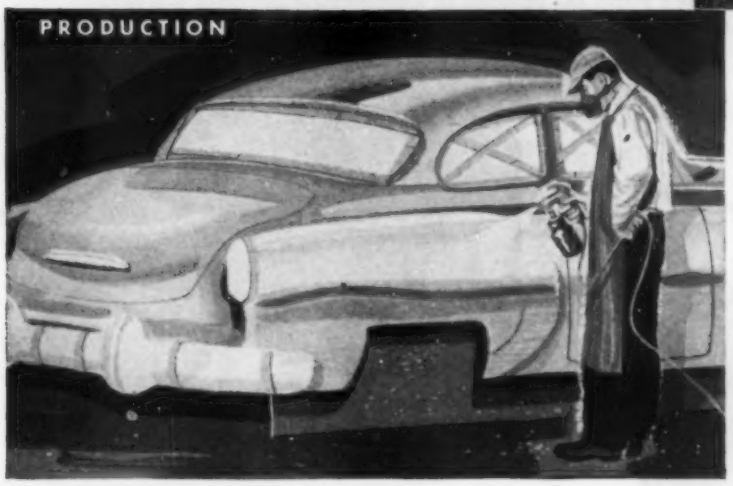
*Patented

PRECISION RECTANGULAR WAVEGUIDE TUBING
MICROWAVE COMPONENTS • MICROWAVE TRANSMISSION ASSEMBLIES • ELECTRICAL CONTACT MATERIAL • FORMED ELECTRICAL CONTACTS
CROSSBAR WELDED CONTACTS • SLIP RING AND SLIP RING ASSEMBLIES • BRUSH ASSEMBLIES
PRECIOUS METALS CLAD TO BASE METALS
SHEET—TUBING—WIRE AND ASSEMBLIES
SENDZIMIR PRECISION ROLLING

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.
Sales Offices: New York • Chicago • Los Angeles • Columbus

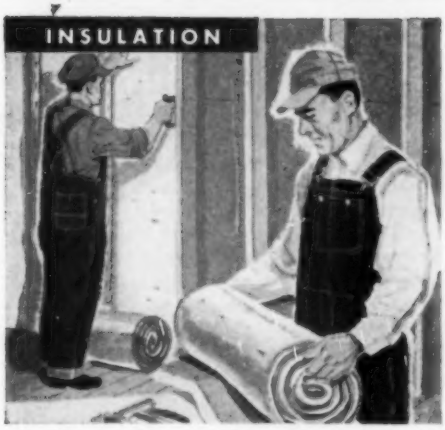
Is there a way to do it better - with paper

Here are paper applications Mosinee helped develop for three industries — Good tip: they may suggest new uses for you!



Mosinee interleaving papers protect mirror-finish stainless steel. The presence of any foreign materials or surface imperfections would mar or scratch the metal's highly polished surface. Mosinee, through highly developed chemical and quality controls, produces these special papers with the required uniform properties.

Special Mosinee masking papers increase auto painting efficiency, reduce costs. These papers must have specific, controlled physical properties including high density and absolute freedom from pin holes to prevent paint penetration. Mosinee "know how" helped develop papers for this special application.



Flame-resistant paper by Mosinee makes good insulation better — safer. In this case, Mosinee flame-resistant paper is produced for the manufacture of home insulation bats. This exclusive Mosinee process may also be used with many types of paper for other products and may suggest a solution to your problem.

THESE applications are typical of the many instances in which Mosinee paper experts have cooperated with industry to develop special analysis papers to perform specific jobs. If your work involves costly or troublesome packaging . . . protection . . . insulation . . . lamination . . . fabricating . . . or processing — a specialized Mosinee paper may provide the answer you've been looking for.

For details on how to do the job better with papers by Mosinee, see your representative, or write —

MOSINEE PAPER MILLS COMPANY
Dept. PE. • MOSINEE, WISCONSIN

Mosinee

— specialist in industrial paper technology — makes fibres work for industry

WATER IS THE ONLY LUBRICANT YOU

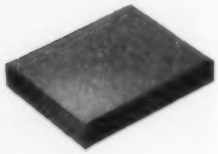
GRAPHITAR® BEARINGS

In various types of pumps and pump motors, rotary pressure joints, torque converters, turbines and similar applications where water or steam is present, GRAPHITAR makes a highly successful bearing material, because GRAPHITAR operates efficiently under heavy loads with water as the only lubricant. This is possible for two reasons: 1.) GRAPHITAR has a lower coefficient of friction than any other bearing material; and 2.) GRAPHITAR is porous and maintains an adequate water film at the bearing surface. In applications where the bearings are relatively inaccessible, the advantage is obvious, for GRAPHITAR eliminates bearing maintenance.

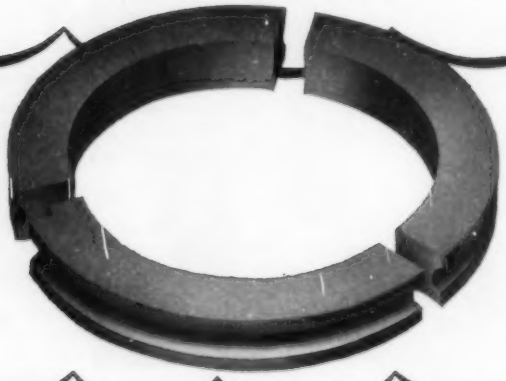
TIN LINE BEARING

SLOTTED WATER PUMP BEARING

WATER PUMP VANE



STEAM TURBINE RING



THE UNITED STATES

OUR 100TH YEAR

NEED FOR

ROTARY PRESSURE JOINT BEARING

STEAM VALVE ROTOR

THRUST WASHER

DEEP WELL PUMP BEARING

GRAPHITAR is a versatile engineering material produced from carbon-graphite powders, compacted under terrific pressures and fused at temperatures up to 4500° F. It can be formed in relatively complicated shapes and ground to tolerances as close as .0005" for seals, bearings, vanes, piston liners and many other parts. In hundreds of difficult applications, GRAPHITAR has proved to be the only completely successful material. GRAPHITAR is lightweight, strong and durable, chemically inert, and virtually unaffected by high speeds, high pressures or temperature extremes. Write today for our illustrated 64-page GRAPHITAR catalog.

WATER PUMP SEAL

186

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Look what *You* can do with Alcoa Aluminum on your Acme-Gridley automatics

Free-machining Alcoa® Aluminum Screw Stock and your Acme-Gridley automatics form smooth-working, fast-working teams. They can knock out aluminum parts easily, cheaply and fast. With aluminum, you can take full advantage of Acme-Gridleys' direct, close-coupled camming and wide-open tooling zone features to thread, tap, ream or deep drill. High speeds and feeds are possible with good surface finishes and close tolerances, uniformly maintained.

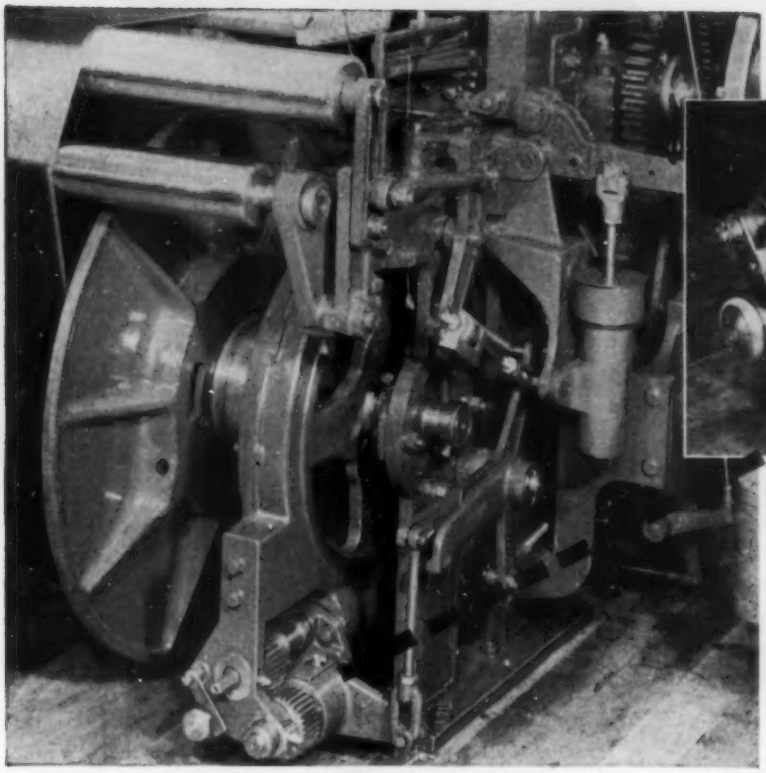
Piece costs are much lower since you can get three times as many parts from a pound of aluminum as from a pound of heavier metals. In addition, they are excellent conductors of electricity and heat. Aluminum parts take all finishes and are highly resistant to corrosion.

Find out for yourself what *you* can do with Alcoa Aluminum Screw Machine Stock. Contact your local Alcoa distributor or Alcoa sales engineer—your sources for Alcoa Aluminum and your short cut to experience in machining aluminum. Their offices are listed under "Aluminum" in the classified section of your telephone directory. Or, write ALUMINUM COMPANY OF AMERICA, Alcoa Bldg., Pittsburgh 19, Pa.

Alcoa offers *Alcoa Aluminum in Automatic Screw Machines*, a 95-page book containing information on tool design, setup and operating techniques. It is available to you at no cost just by writing on your company letterhead telling us your job function.

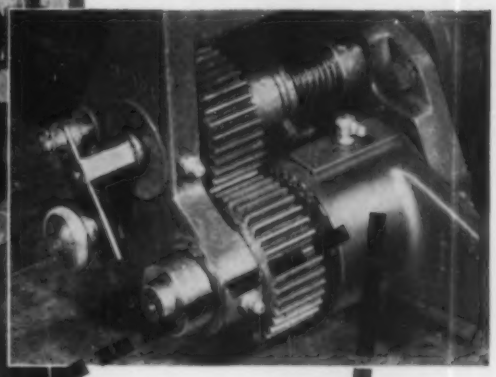
ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA



Crompton and Knowles' new Multi-Purpose Loom

Composite let-off mechanism



Morse 200-Series Cam Clutch

Morse Cam Clutches help insure uniformly woven fabrics on new looms

Simplicity of design, plus ease of installation and maintenance, make Morse 200-Series Cam Clutches as readily adaptable as bearings in numerous industrial applications.

For instance, in the new Multi-Purpose Looms manufactured by Crompton and Knowles and illustrated above, the 200-Series Cam Clutch is used to insure uniformly woven fabrics.

The composite let-off mechanism, an important feature of these looms, lets off yarn from the beam as it is required by the fabric being woven. It is important that the proper tension is maintained in the yarn throughout the application.

Since the amount of let-off required for each pick will vary slightly, an infinite adjustment of the let-off motion is necessary. It is obtained through the use of the Morse Cam Clutch.

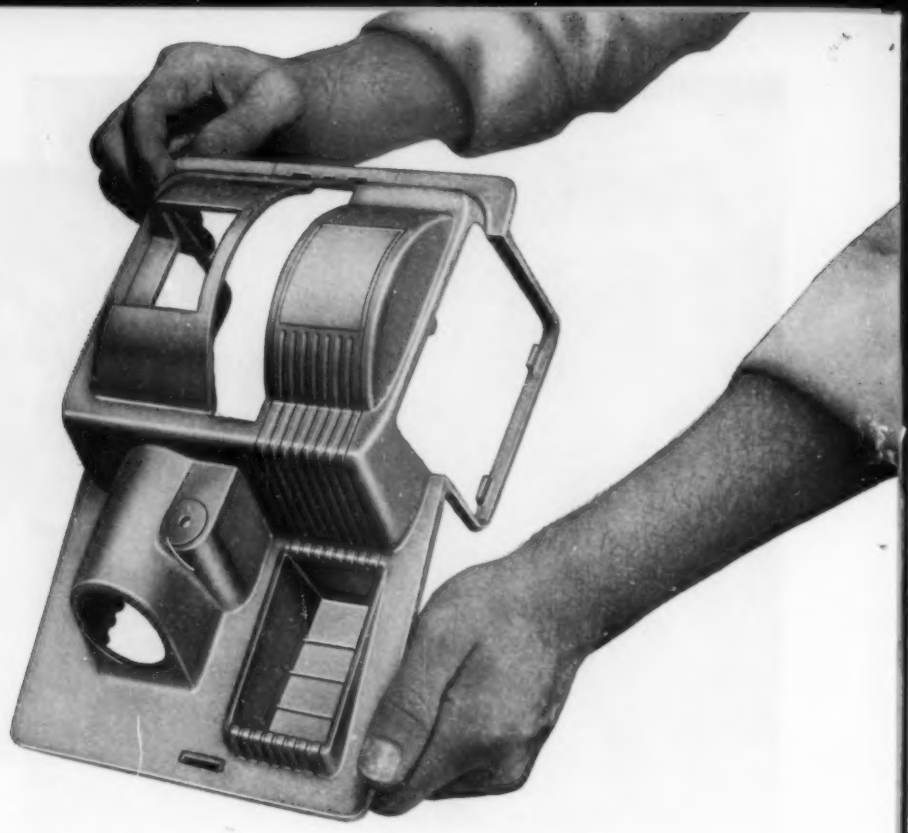
The Morse 200-Series Cam Clutch is, in effect, a self-contained ratchet with an infinite number of teeth. It is far more accurate than a ratchet and pawl mechanism, and therefore, in this application, insures uniformly woven fabrics. This clutch is a full cam design, combining maximum torque with minimum space requirements for indexing, over-running and backstop applications.

Write for data-packed catalog C 12-54 for complete engineering and dimensional data on the Morse 200-Series Cam Clutch. **Morse Chain Company, 7601 Central Avenue, Detroit 10, Michigan.**

MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893



this die casting had a "deadline"...

● To Meet A Tight Schedule, We Had To Produce This Casting In Volume—Fast!

From drawing board to final polishing, this Revere projector housing was a race against the clock. It had to be ready in time to meet a "rush" production schedule – and it was. We can beat deadlines for you, too, if necessary. Whatever type of die castings you need – small or large, simple or intricate – count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

44 years of helping industry to "Make It Better"

Stewart **DIE CASTING**

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

"You've got to use the right club!"

"Par 3—140 yards—plenty of trees—looks like a full 7 iron for me."

"I'd probably be better off with a number 6."

"Funny how identical shots sometimes demand different clubs. Again, the old thing of picking the right tool for the job. It's like we were saying the other day about that condenser tube for Jones & Company—you felt sure we needed a different alloy—and you certainly proved it to our satisfaction!"

"Well, Jack, I think everyone agrees, specialization is a must. For example, one of our products, Wolverine Trufin*, is produced in four different forms—each designed to meet a specialized customer need. One of these four types will handle just about any finned tube job."

"We're using your Trufin Bi-metal in our plant now, Bill."

"That's type L/C. It has aluminum fins and a copper lining. We produce other types that are used in shell and tube heat exchangers and condensers, water heaters and hot air applications."

"You people keep talking one piece construction whenever you mention Trufin."

"We sure do. The fins are literally squeezed right from the tube wall. Because you have the integral construction, the tube retains its higher rate of efficiency through changes in temperature, pressure and vibration."

"Trufin efficiency is another big advantage, Jack. It gives you more surface condensing capacity within a given area and requires far less space to do a bigger job for you."

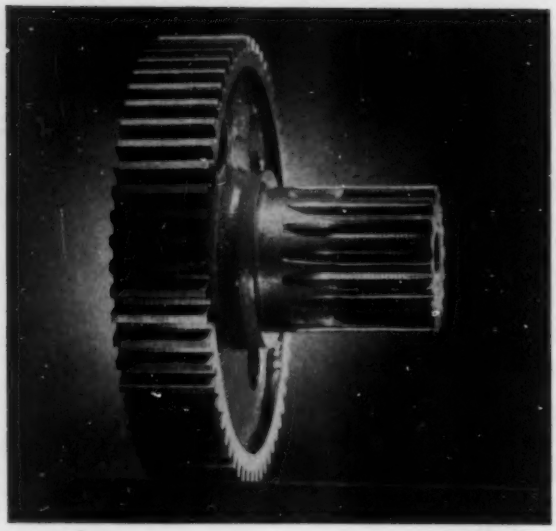
IF STEPPED-UP EFFICIENCY IS PAR FOR THE COURSE: then you'd better investigate the multi-fold possibilities of Trufin—right now! It's available in copper, copper-base alloys, aluminum and electric-welded steel. And write for a copy of Wolverine's Trufin data sheet. It's a handy thing to have! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

*REG. U.S. PAT. OFF.

"Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario."

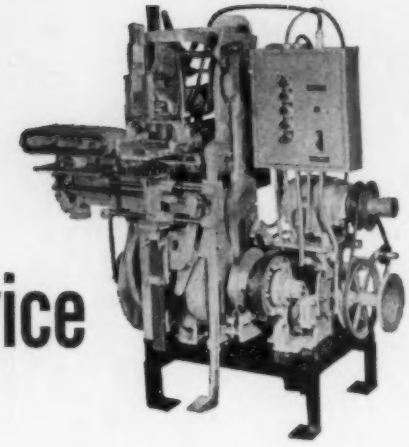
WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK



Fit as a fiddle . . . aptly describes this Ductile Iron camshaft drive gear. It was installed in an automatic labeling machine on March 3, 1952, at Bestway Products, Inc., Rahway, N.J. Ductile Iron "as cast" provides high strength, resistance to wear and galling, with good notched endurance properties. Inspection of the gear on June 15, 1953, found it to be as good as new and it's still on the job.

12 TIMES Longer Service with Gears of Ductile Iron



Harmony in motion . . . is essential in the musical record business, where downtime of equipment stops deliveries with dire results. Look at this "Pony Label-Dri" automatic labeling machine, produced by New Jersey Machine Corporation, Hoboken, N.J. One of this type labels records for Bestway Products, often 'round the clock.

* * *

"You can't sell Christmas records in January."

That's the way Louis Quitoni, Plant Superintendent, of Bestway Products, Inc., put the problem when his labeling machine – geared for 1,000,000 records a month – kept breaking down.

Imagine the backlog that built up, and what happened to deliveries . . .

Until this Ductile Iron gear was installed.

"The latest gear . . . machined from a Ductile Iron casting," writes Bestway Products, "has given a truly remarkable performance."

The two principal requirements of this gear are 1) a high order of wear resistance and 2) ability to withstand sudden shock loads imposed by a knife clutch. This machine is intermittently operated and tripped 3 or 4 times a minute.

So far, Ductile Iron has given 12 times the service of high test iron gears which failed in about 2 *months*. So far, the initial Ductile Iron replacement has served 2 *years*, and it's still on the job.

New Jersey Machine Corporation, builder of this machine, as a result of this service life has standardized on Ductile Iron for camshaft drive gears for original and replacement installation.

In plants from coast to coast, Ductile Iron is saving money at every turn. How? By its remarkable load-carrying ability and wear resistance, combined with excellent castability, ready machinability and moderate cost.

Send us details of prospective uses. We'll gladly suggest a source of supply from some 100 authorized foundries now producing Ductile Iron under patent licenses. Request a list of available publications on Ductile Iron . . . mail the coupon now.

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

Please send me a list of publications on DUCTILE IRON.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

the amazing "lubrication fitting" that thinks ahead...

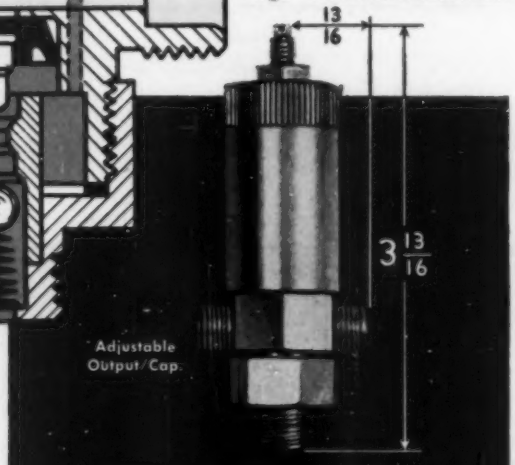
ALEMITE Accumeter®

lets you design automatic, fool-proof lubrication right into any machine—simply, economically...offers the operating savings industry will buy!

When a machine is designed with multiple lubrication fittings that require manual attention, the user of that machine is sure to encounter a number of problems. People being what they are, some bearings will be neglected, others over-lubricated. Further, hand lubrication is costly and valuable production time is lost when machines must be shut down for lubrication.

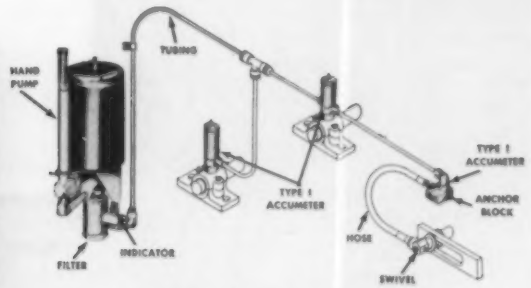
You avoid all of these troubles with the Alemite Accumeter. This amazing valve fits directly on bearings – meters an exact shot of oil or grease *automatically—at pre-determined intervals—while the machine is in operation!* Time, production and maintenance costs are cut to the bone! With all these advantages, it is small wonder that 95% of all major plants buying machine tools specify centralized lubrication.

The Alemite Accumeter system is simple to design and build into any machine. Automatic Accumeter Systems assure you positive, low-cost lubrication. Find out about these automatic systems now. See the savings, the efficiency they add and you too will specify Accumeter!



Type 1 Accumeter Valves

For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Spring pressure provides gradual feed. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.



offers all these advantages!

- Eliminates shutdown time for lubrication. Adds productive time to machine output
- Seals completely against dirt, grit, water all the way from "Barrel-to-bearing"
- Prevents bearing troubles due to neglect or use of wrong lubricant
- Services all bearings—including those inaccessible or dangerous—in one operation
- Avoids work spoilage and bearing repairs due to over-lubrication

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—*equal to* 122 YEARS *of twice-a-day service!*

ALEMITE
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A PRODUCT OF SW STEWART-WARNER

Free—*Alemite Accumeter Catalogue and Engineering Data Book.*

ALEMITE, DEPT. T-74
1850 Diversey Parkway, Chicago 14, Illinois

Please send me my free copy of the Alemite Accumeter Catalogue and Engineering Data Book.

Name_____

Company_____

City_____ State_____

Jack & Heintz Customized Motor

AMMCO TOOLS, INC.

COMMONWEALTH AVENUE — NORTH CHICAGO ILLINOIS

May 5, 1954

Jack & Heintz, Inc.
Motor Division
Cleveland 1, Ohio

Gentlemen:

After switching to your line of special motors for our Model 2000 Safe-Arc Brake Shoe Grinder, we knew that we had saved substantially in our manufacturing costs. For the record, we decided to determine the exact amount.

We are sure you will be pleased to know that your new Customized Motor has cut our actual manufacturing costs $2.11 per unit over the standard motor we previously used. This amounts to a saving of over $5.00 in list price.

It enabled us to hold the line on the list price of our Safe-Arc Grinder at the very time a general increase was necessary on some of the rest of our line of Brake Service and Engine Repair Equipment.

Sincerely,

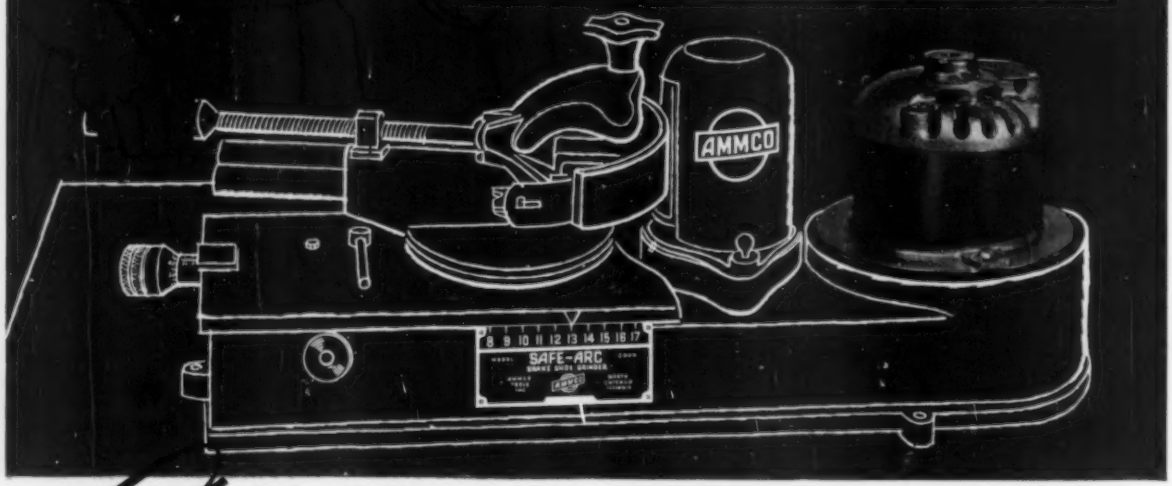
AMMCO TOOLS, INC.

Dick Stevenson

Richard D. Stevenson
Service Manager

RDS/ae

MANUFACTURERS OF AUTOMOTIVE ENGINE REPAIR, HONING, AND BRAKE SERVICE EQUIPMENT FOR OVER 30 YEARS



Customized JACK & HEINTZ

Enables AMMCO to Hold Price Line

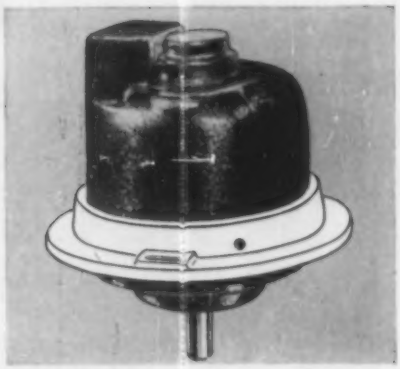
Manufacturing costs cut $2.11 per unit

Ammco Tools, Inc., manufacturer of the famous "Safe-Arc" Brake Shoe Grinder, and other automotive repair equipment, needed a practical solution to a costly manufacturing problem—the necessity of a special flange ring to hold a standard motor in position on their new grinder.

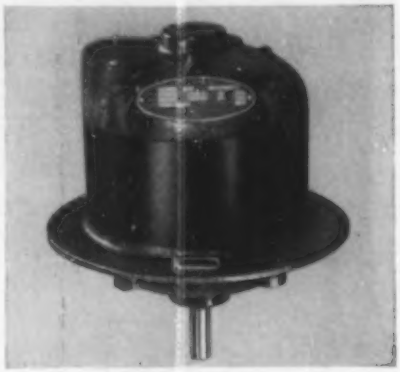
Jack & Heintz engineers supplied the answer with a *Customized* Motor. A specially engineered drive end bell *incorporates the flange as an integral part* of the J & H motor.

Here's how AMMCO saved money with a J & H Customized Motor:

1. Eliminated expensive patterns for cast-iron flange rings.
2. Eliminated precision machining of rings and faced surfaces.
3. Eliminated drilling and tapping of three screw holes for securing ring to motor.
4. Eliminated facing of bosses where bolts hold ring to body of machine.
5. Cut time for mounting motor to grinder by *50%*.
6. Eliminated flange ring inventory problem.
7. Gave entire unit greater rigidity . . . flange is now an integral part of the motor.



BEFORE—Standard motor used with separate flange ring. Flange ring created assembly problems, increased manufacturing costs.



AFTER—The practical J&H solution to Ammco's problem includes this sturdy, flanged end bell. Improves product appearance and gives greater rigidity to motor-grinder assembly.

Design your product to do a job . . . *not to fit a motor*

Avoid those motor compromises in your product through an engineering philosophy that's geared to solve your special needs. Design your product to do a job . . . not to fit a motor! Write Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

©1954, Jack & Heintz, Inc.

ELECTRIC MOTORS J&H

U. S. Air Force crash trucks and rescue vehicles by American-LaFrance-Foamite Corp., Elmira, N.Y., use Revere Aluminum.

Aluminum Conductor Busway, light and economical, by Bull Dog Electric Products Co., Detroit, Mich., uses Revere Aluminum (EC Grade) Bar.

Industry Depends Upon The Versatility Of REVERE ALUMINUM

Revere meets the requirements of industry with a wide range of aluminum alloys in extruded shapes, coiled sheet, drawn tube, electrical bar and forgings. And industry knows the fine, uniform quality of Revere Aluminum. Each customer's requirements, based on their specific uses of Revere products, receives careful attention by Revere quality control.

For assistance in the efficient manufacture of products using aluminum, you are invited to utilize Revere's Technical Advisory Service.

REVERE ALUMINUM

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N.Y.

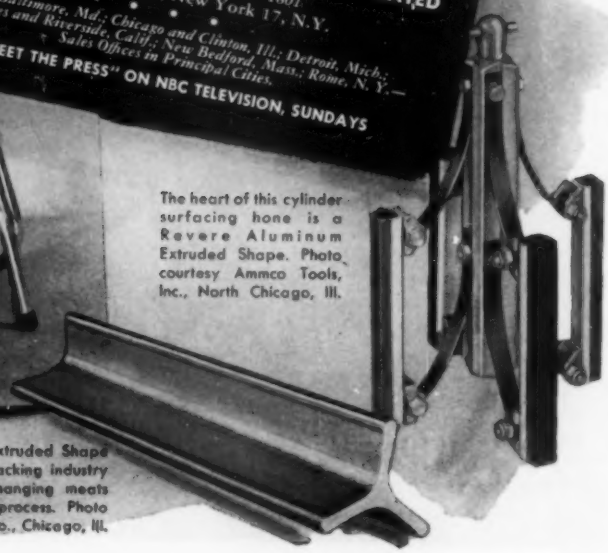
• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities.

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

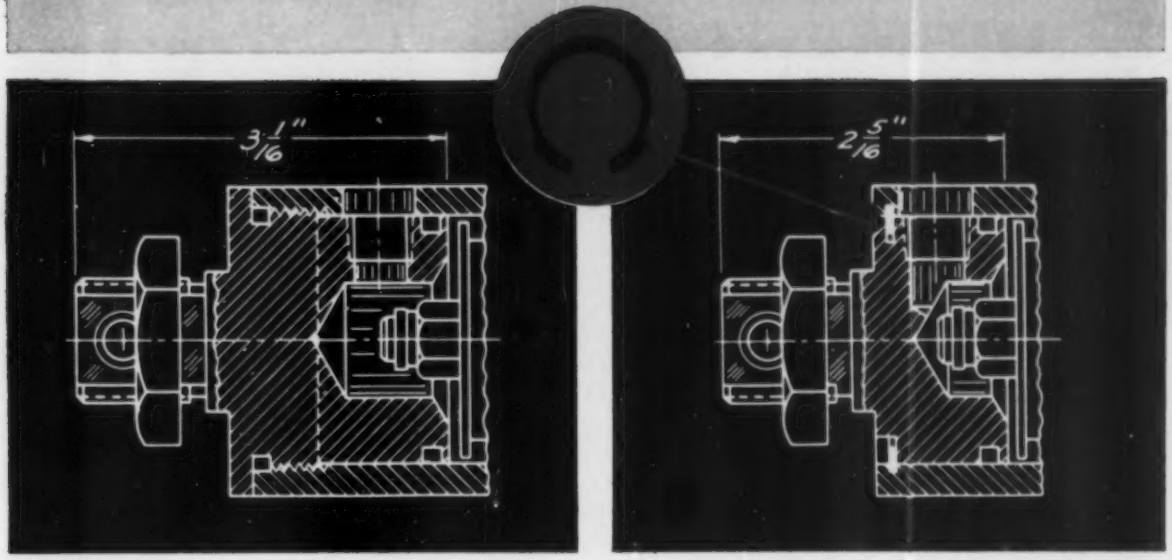
Many makers of indoor and outdoor chairs and furniture use Revere Aluminum Tube. This chair by Lawnlite Co., Miami, Florida.

The heart of this cylinder surfacing hone is a Revere Aluminum Extruded Shape. Photo courtesy Ammco Tools, Inc., North Chicago, Ill.



A Revere Aluminum Extruded Shape is used by the meat packing industry as smoke-sticks for hanging meats during the smoking process. Photo courtesy The Globe Co., Chicago, Ill.

Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut..17 minutes
Weight Saved.....1¾ lb.
Length Shortened.....1½ inches
Cost Saved.....$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

■ Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

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WALDES TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,949; 2,416,852; 2,420,921; 2,428,341; 2,439,795; 2,441,949; 2,455,165; 2,483,390; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

PN876

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name.....

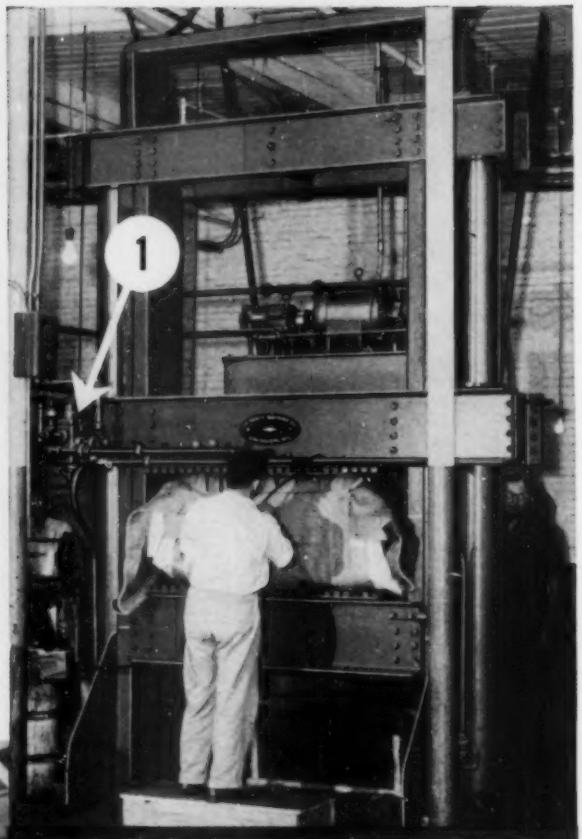
Title .....

Company .....

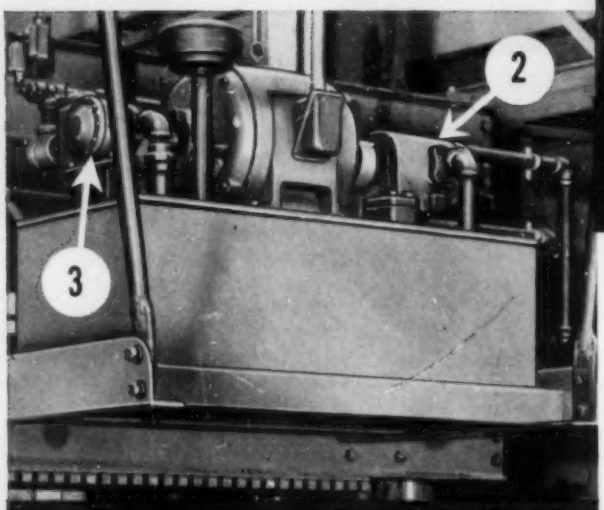
Business Address.....

City..... *Zone*..... *State*.....

VICKERS®
HYDRAULIC EQUIPMENT
helps produce
BETTER BALES at *LOWER* COST



Beaty One-Floor Draw Bar Hydraulic Presses need no pit, are self-contained, complete more bales per hour, require less electric power, and the bales contain greater yardage of cloth. VICKERS Hydraulic Equipment is used exclusively. Press operation is conveniently controlled by hand lever on VICKERS 4-Way Valve (No. 1).



VICKERS Custom-Built Hydraulic Power Unit was designed and built to meet the particular needs of this press. A double-end motor drives two standard VICKERS Vane Type Pumps (No. 2 a small-volume pump for maximum operating pressure of 2000 psi; No. 3 a large-volume pump for maximum operating pressure of 1000 psi.) Both pumps deliver oil for the exceptionally fast closing of the press; during bale compression at 2000 psi, pump No. 3 is automatically unloaded to reduce power requirement to a minimum.

The advantages of using VICKERS Hydraulic Equipment as illustrated here by the Beaty Press are representative of what has been accomplished on many types of Textile machinery.

In the Textile industry, the use of Vickers Hydraulics is growing rapidly because of its adaptability, efficiency and economy. It offers exceptional advantages in simplification of design, ease of installation, accuracy and flexibility of control, and low maintenance. Automatic overload protection and inherent self-lubrication are additional highly desirable characteristics.

For further information about the benefit of Vickers Hydraulics ask our nearest Sales Application Engineering Office for a copy of new Textile Bulletin 54-66.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

"This Needle Bearing can carry a terrific load"

For its size and weight, the Torrington DC Needle Bearing has a greater rated radial load capacity than *any* other type of anti-friction bearing.

The Needle Bearing is only slightly larger than a plain bearing, yet it delivers efficient anti-friction performance with a minimum of maintenance attention. Its drawn and hardened outer shell, when pressed into a recommended housing bore, serves as the outer race. A full complement of small diameter rollers gives many lines of contact to distribute the load.

Your product can gain many advantages from the Needle Bearing's design and performance. Housings, mountings and other related parts can be made lighter and smaller. Lubrication is needed less frequently since the turned-in lips of the bearing keep lubricants in, dirt out. And you get high capacity anti-friction performance for little more than the price of a plain bearing.

Our Engineering Department will be glad to lend a hand in design analysis and bearing selection.

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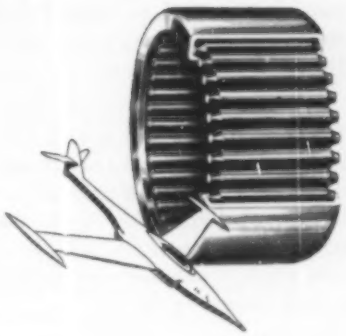

Torrington Needle Bearings serve the aircraft industry in many important applications where weight and space savings are vital. On both military and civil aircraft, Needle Bearings give high-capacity anti-friction performance at high speeds, high altitudes and over a wide range of temperatures.

How this "S" Monel Sleeve... costs Con Edison less than plain water!

"Machined in the Mold." All the machining required to form the three steps on this "S" Monel shaft was eliminated by Inco casting specialists. They turned the trick in the centrifugal mold itself by using a special carbon insert. Result: a shaft sleeve with three different outside diameters and a constant inside diameter — *as cast!*

At Consolidated Edison's East River Station, they used to replace shaft sleeves in the circulating pumps within 2½ years — often sooner.

And you can easily understand why. New York's East River is both salty and sandy. Besides, two sewer trunks empty into the river less than 300 feet from the pump intake. When that gritty, brackish water gets in the gland seals, abrasion and corrosion go right to work on the sleeves.

Con Edison's maintenance engineers considered using fresh water in the packing gland. The cost of the water practically ruled this out. Then they compared the cost of "S" Monel sleeves with the price of those they had been using. If "S" Monel sleeves lasted long enough in the salt water, they'd more than pay their own way. *It was worth a try.*

Did the "S" Monel sleeves work out satisfactorily? Here's the answer in Con Edison's own words:

"The first of our 'S' Monel sleeves was installed in 1949. The extra cost of a new 'S' Monel sleeve — installed — is less than the added cost of supplying plain water to the gland."

Perhaps an Inco Casting—or an Inco Nickel Alloy — can solve a costly service problem for you. Our 16-page booklet, *Standard Alloys for Special Problems*, is designed to help you select the Inco Nickel Alloy best suited to withstand destructive service conditions. Write us for a free copy.

The International Nickel Company, Inc.
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"KR"® MONEL • "S"® MONEL • INCONEL®
INCONEL "X"® • INCONEL "W"®
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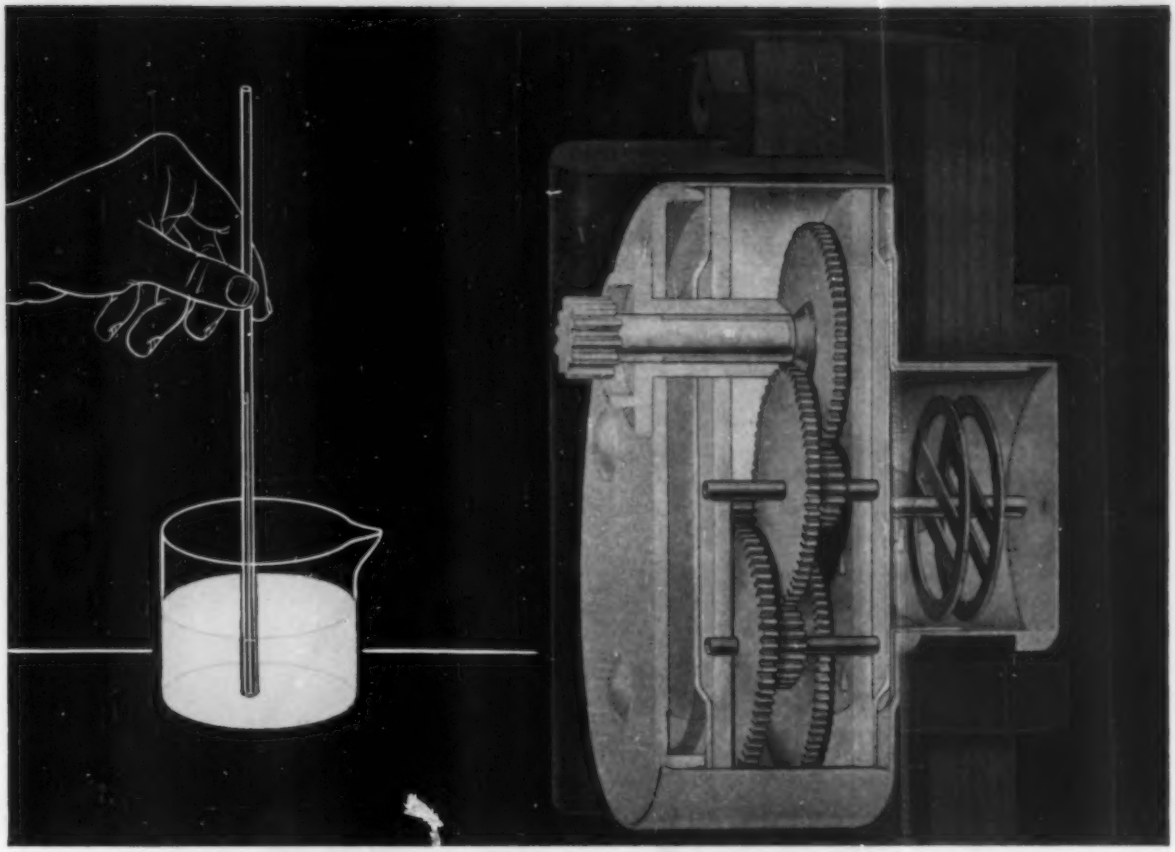
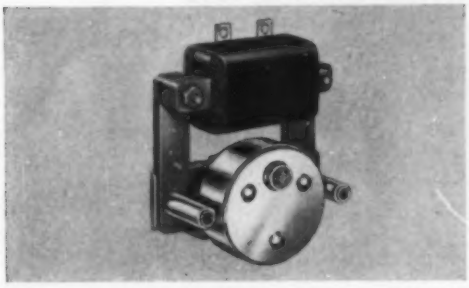
LOW CARBON NICKEL • DURANICKEL®

Inco Nickel Alloys



MORE evidence of the extra VALUE in TELECHRON timing motors . . .



Lubrication is only part of the Telechron motor story. Lightweight rotors assure quick starting. Gears are hobbed for quiet operation. Power-line accuracy means true synchronous performance. Separation of the field from the rotor results in cooler operation and longer life.

The accurate, dependable, inexpensive Telechron Synchronous Motor is the heart of timing you see everywhere . . . in clock-radios, washers and dryers; in heating controls, refrigerator defrosters and air conditioners . . . in industrial time switches, recorders and instrumentation.

CAPILLARY ACTION FEEDS OIL TO MOVING PARTS

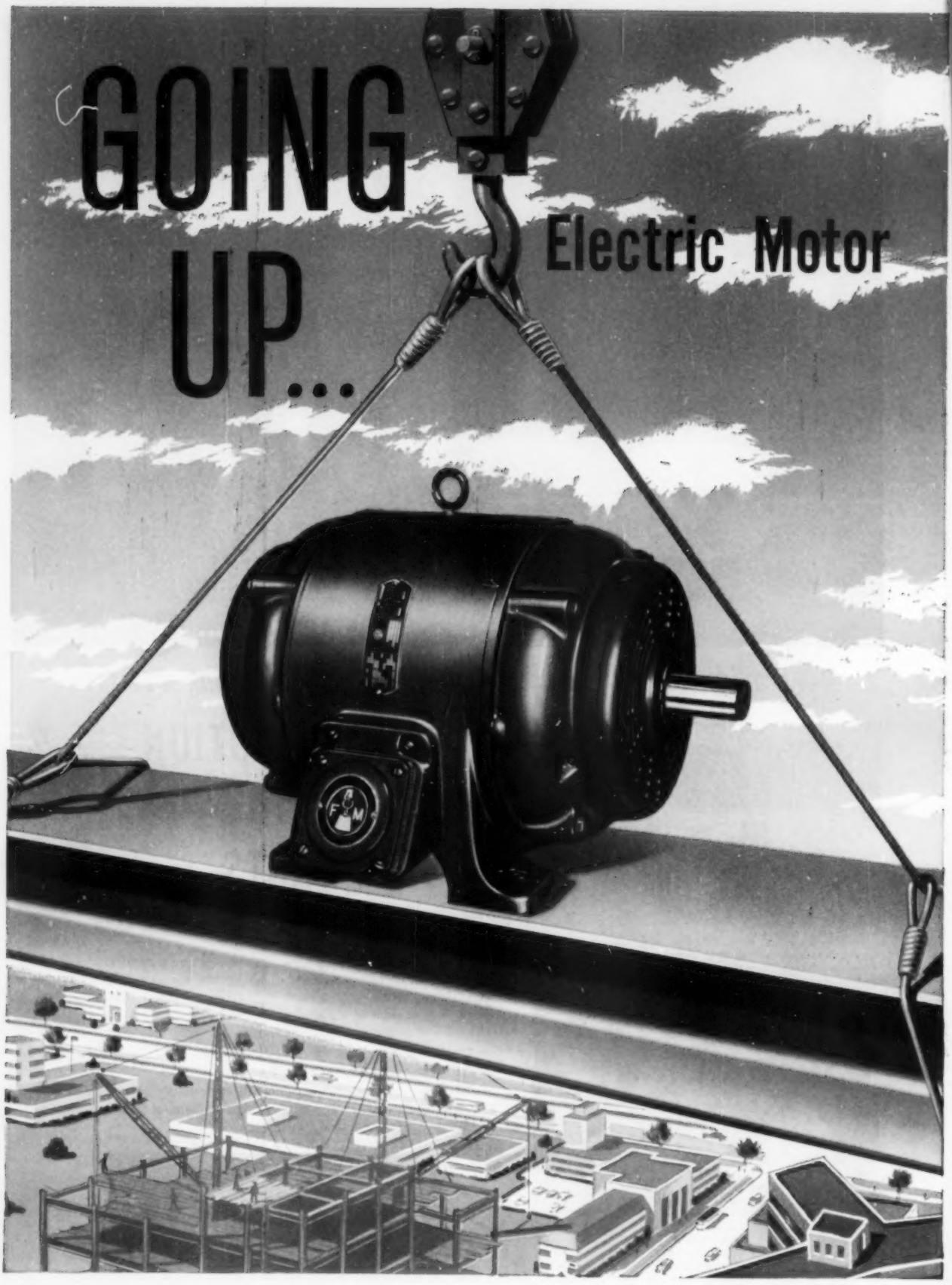
One secret of the lasting accuracy of a Telechron timing motor is its exclusive sealed-in system of lubrication.

Each Telechron motor carries just the right amount of oil, locked-in against dirt and dust. The oil is drawn up the spaces between bearings and capillary plates by the same free-flowing process that pulls water up the hollow stem of a plant—or a glass tube. Bearings are constantly covered with a thin coating of oil.

This way the oil lasts the life of the motor—which, with a Telechron timing motor, can be for years and years.

Write for complete catalog and full information on our Application Engineering Service. Telechron Department, General Electric Company, 17 Homer Avenue, Ashland, Mass.

Telechron
MARK OF TIMING LEADERSHIP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To a towering structure of design achievement Fairbanks-Morse adds still another outstanding member . . . a compact new enclosed motor . . . backed by an engineering tradition which has been a-building for more than a century.

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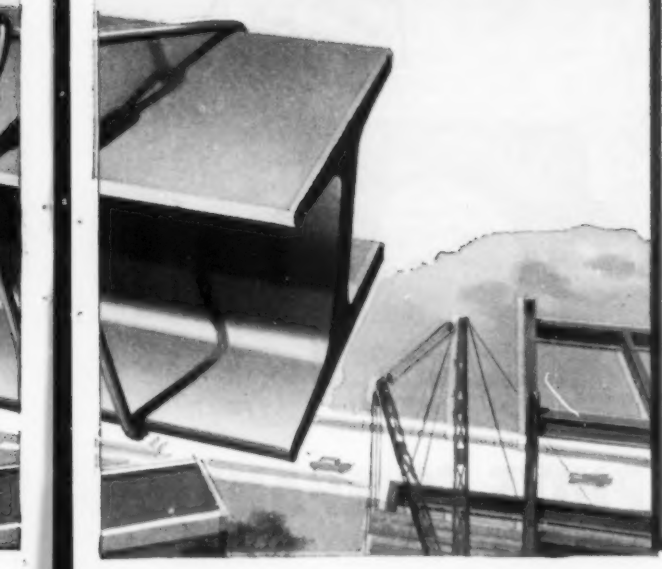
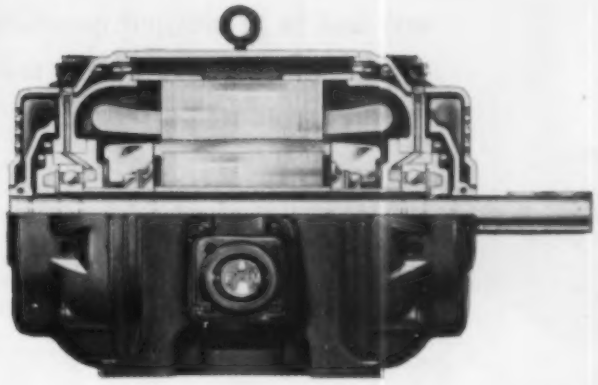


NEW FAIRBANKS-MORSE
TOTALLY ENCLOSED FAN-COOLED MOTORS



TOTALLY ENCLOSED—Wherever adverse operating conditions are encountered, F-M totally enclosed construction effectively insures electrical parts and bearings against contamination by dirt, abrasive dusts, metal particles, corrosive gases and steam.

DOUBLE-END VENTILATION—Cooling air is drawn through guarded openings in both fan shields and uniformly circulated through cored passages surrounding the sealed inner shell. Efficient heat-transfer action insures uniform internal cooling. Exhaust air is discharged through bottom of frame—not across motor and driven machine.

COPPERSPUN ROTOR—Exclusive Fairbanks-Morse feature—an indestructible one-piece rotor—homogeneous, free from flaws for maximum strength and lifetime service.

CONDUIT BOX—New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

BEARINGS—Precision ball bearings are effectively sealed against grease leakage and contain ample lubrication for extended periods of rugged service. Convenient means are provided for flushing and relubricating if desired. Cartridge bearing construction is standard on all larger ratings.

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a name worth remembering when you want the best

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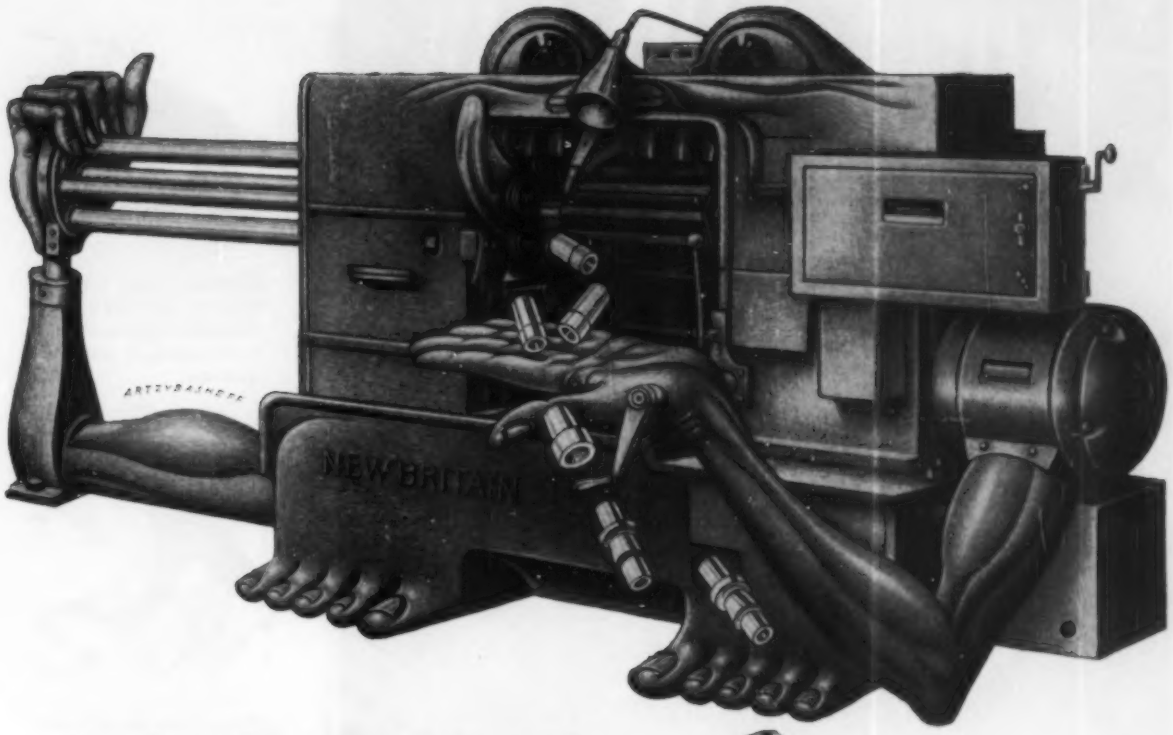

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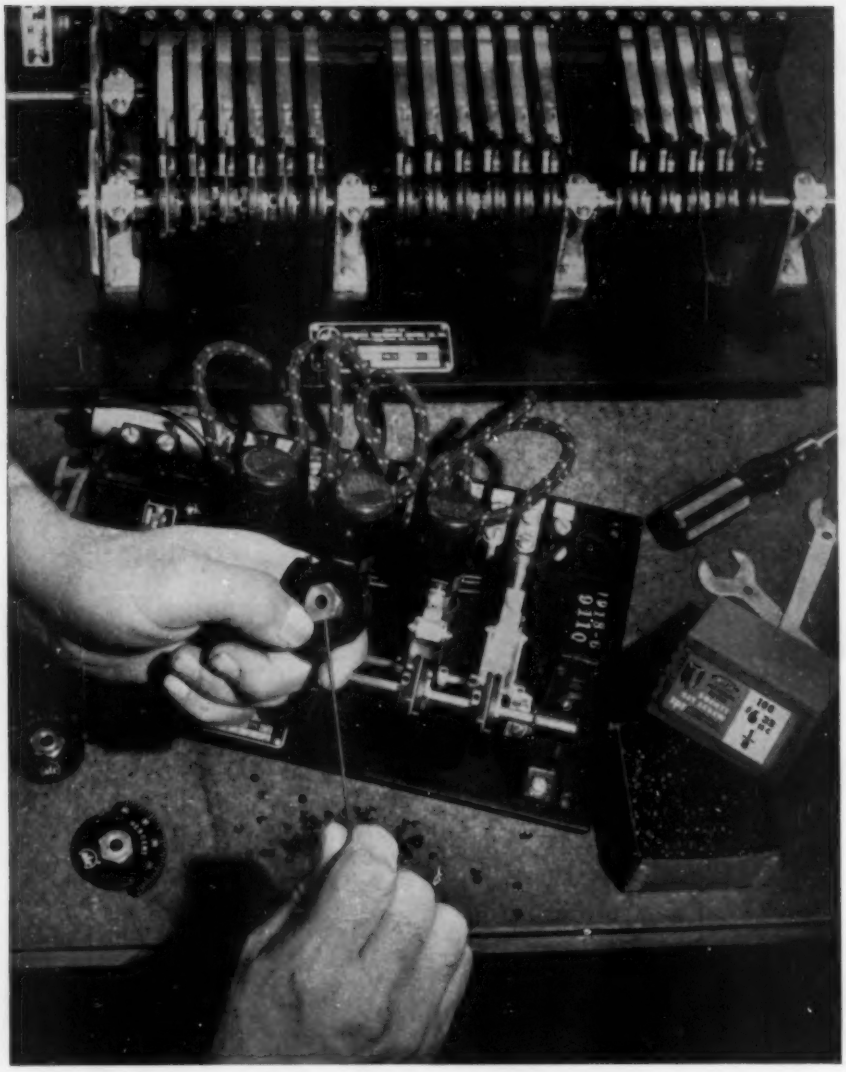
With Alcoa Aluminum Screw Machine Stock, you can operate your New Britains at top feeds and speeds and get fine surface finishes with consistently uniform tolerances. You can lower your piece costs as much as one-third. You get three times as many parts from a pound of aluminum as from a pound of the heavier metals. Aluminum takes all finishes—resists corrosion—conducts electricity and heat exceptionally well.

Find out how aluminum can help you. Contact your local Alcoa sales engineer whose office is listed under "Aluminum" in the classified section of your telephone directory. Or write ALUMINUM COMPANY OF AMERICA, 853-G Alcoa Building, Pittsburgh 19, Pa.

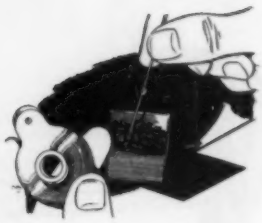
PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers—a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.

ALCOA ALUMINUM

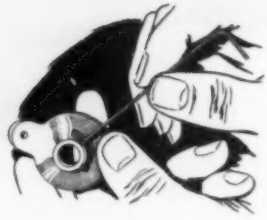
ALUMINUM COMPANY OF AMERICA



Two UNBRAKO Self-Locking Socket Set Screws are used on each cam of these precision multicircuit cam timers. The screws position the cams so as to control accurately the sequence and duration of one or a series of individually timed machine or process operations.



Assembler picks up tiny UNBRAKO set screw with long arm key preparatory to threading it into cam assembly.



He inserts the UNBRAKO, and turns it into the assembly; then after positioning cam, tightens it. The accurate depth and size of the hex socket result in maximum torquing—the knurled cup point holds the cam accurately in place.

UNBRAKOS—made of heat treated alloy steel—have fully formed threads, Class 3 fit; are supplied in standard sizes from #4 to 1".

You'll need less space for storage when you use UNBRAKO Standards—stocked by your distributor

You'll need less space for storage and be able to carry a smaller inventory, because standard UNBRAKO socket screw products are in stock at your local industrial distributor's. And you'll save time and money, because deliveries are prompt. For more information, write for UNBRAKO Standards—a complete listing of socket screw products made by the world's largest manufacturer of these precision fasteners. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

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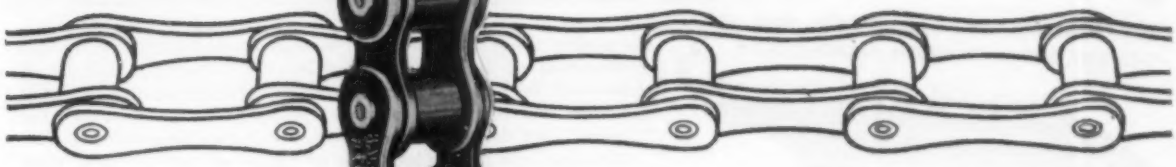

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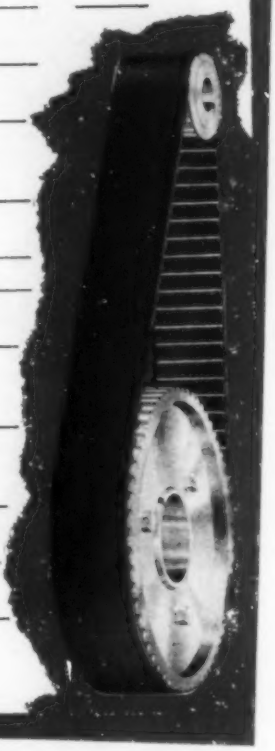
Gilmer THE ORIGINAL "TIMING" BELT DRIVE

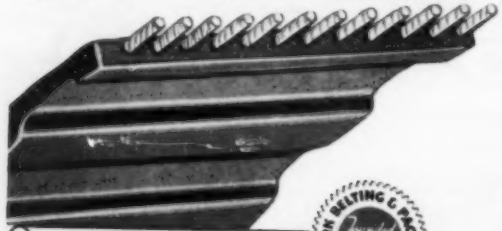
versus other forms of Power Transmission

	GILMER "TIMING" BELT DRIVE	FLAT BELTS	CHAIN	V BELTS	GEARS
1. Can it transmit 1/100 to 300 HP without slippage . . . and without lubrication?	Yes				
2. Does it eliminate noise and vibration caused by metal-to-metal contact?	Yes				
3. Does it operate at maximum efficiency, indefinitely, without take-up?	Yes				
4. Does it make possible very compact, short-center drives of ratios up to 15-to-1?	Yes				
5. Does it eliminate need for initial tension, permitting all the drive's tension to be used effectively . . . and reducing bearing wear?	Yes				
6. Can it operate satisfactorily at peripheral speeds above 12,000 FPM?	Yes				
7. Does it maintain constant angular velocity?	Yes				
8. Is its weight very low in proportion to its strength?	Yes				
9. Does it make possible precise "timing", without appreciable backlash, between two or more widely separated shafts?	Yes				
10. Does it eliminate the expense and added weight of lubricants, lubricating devices and covers?	Yes				
11. Does it save so much power as to sometimes permit use of lower-powered motors?	Yes				
12. Does it have unusually long, maintenance-free service life?	Yes				

WHEN PLANNING A DRIVE, CONSIDER ALL FIVE!



NEOPRENE-ENCASED, CABLED STEEL WIRE GIVES THE BELT GREAT STRENGTH WITHOUT BULK



Naturally, these questions are phrased to emphasize the unique *combinations* of features provided by the "Timing" Belt drive. Question 1, for example, might have been divided into two separate questions. But this would not point up the important fact that the "Timing" Belt drive is the *only positive drive requiring no lubrication.*

Certainly, the four older types of drives will always have their special places in the power transmission picture. The important fact is that the design engineer now has at his disposal a *fifth* type of drive ideally suited to so many applications that more than a million are now in use.

Write for your copy of the Gilmer "Timing" Belt Stock Drives Manual, to Gilmer "Timing" Belt Division at the address below.

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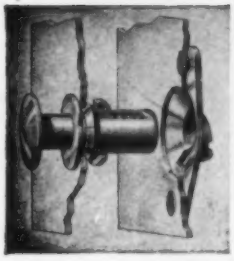
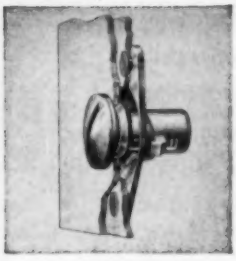
NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

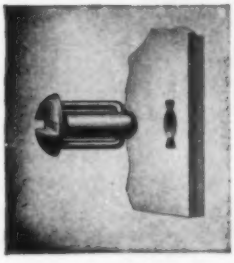
America's Oldest Manufacturer of Industrial Rubber Products

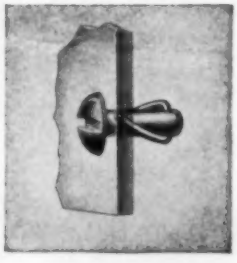
3 ways to save on assembly costs



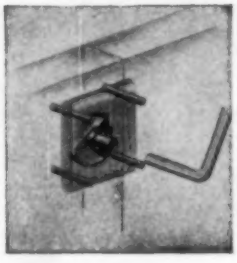


QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.





SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. SPRING-LOCK is now available in high-impact plastic. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

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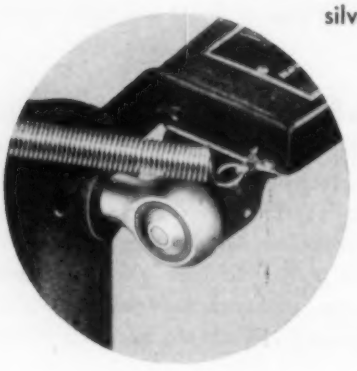
HEIM *Unibal* ROD ENDS

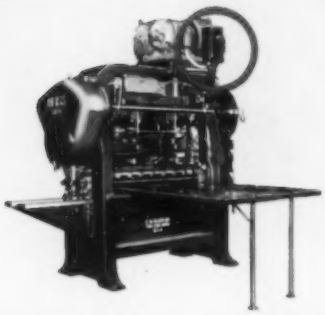
The New Hermes Engraving Machine Corp. of New York, world's largest manufacturer of precision engraving machines for the jewelry trade and also for industrial use, utilizes a pair of Heim Rod Ends to insure smooth and dependable functioning of the engraving arm. The compactly designed Engravographs are noted for their simplicity of operation in the quality engraving of watches, jewelry, and silverware as well as of dials, nameplates, signs and instrument panels.



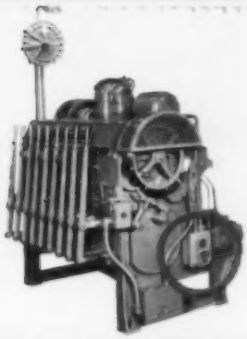
In addition to their ease of installation, Heim Rod Ends were especially selected to align and correct unevenness in the central swing bracket, because of their smooth and positive action regardless of the irregularity of working surface.

Send for the Heim complete catalog

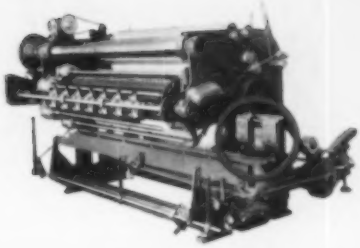
THE HEIM COMPANY
FAIRFIELD, CONNECTICUT



PERFORATING PRESS



GAS CONTROL



PAPER ROLL REWINDER

ACROSS-THE-LINE STARTERS FOR ALL TYPES OF MACHINES

A Uniform Line up to 300 HP, 220V; 600 HP, 440-550V

It is a distinct advantage to both buyer and user of motorized machines if the across-the-line starters have a family resemblance over the entire range up to 300 hp, 220 v; 600 hp, 440-550 v. For example, Allen-Bradley solenoid starters are so nearly alike over this range that to be familiar with the structure and operation of a 5 hp starter provides equal familiarity with an Allen-Bradley 500 hp starter. This advantage is limited only to the Allen-Bradley line.

Bulletin 709 solenoid starters are available in dust-tight, waterproof, explosion-proof, and corrosion-proof enclosures.

The Allen-Bradley Handy Catalog is a handbook of control information. Send for a copy.

Sizes 0 to 5

A-B Quality

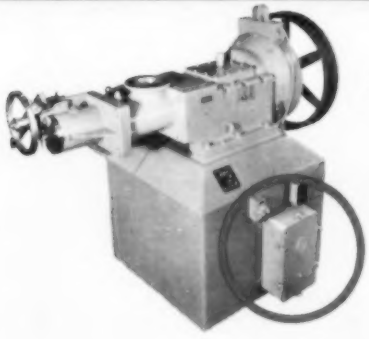
ALLEN-BRADLEY

SOLENOID STARTERS

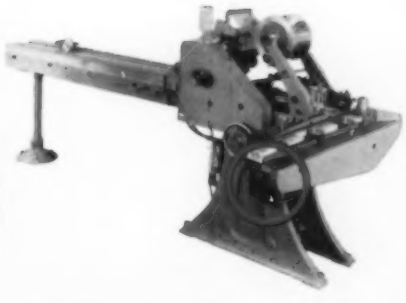
QUALITY

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis

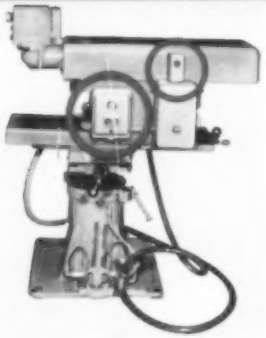
EXTRUDING MACHINE



WRAPPING MACHINE



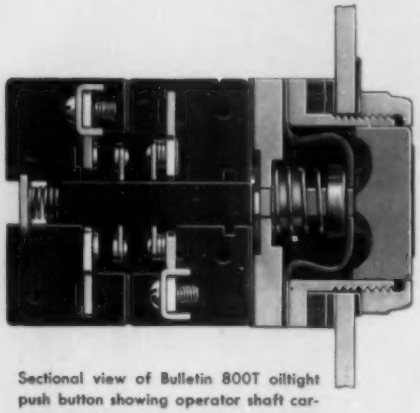
BURR REMOVER



7-54-MR

OILTIGHT PUSH BUTTONS

Start Button with Double Pole NC and NO Contacts

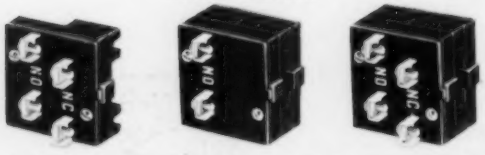


Sectional view of Bulletin 800T oiltight push button showing operator shaft carrying moving contacts. Stationary contacts are mounted in the molded contact block. The oiltight flexible diaphragm is between push button and contact block.

Assemble any combination of operators and contact blocks

OPERATORS

CONTACT BLOCKS

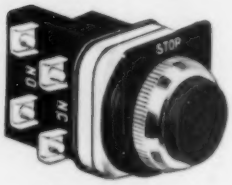


Bulletin 800T operators and contact blocks are available in many forms. They may be assembled interchangeably in various combinations, thus reducing your motor control parts inventory.

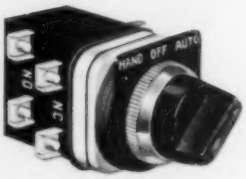
Here are a few of the many Allen-Bradley oiltight pilot units for machine tool service. They are available for mounting on machine frames in a variety of single units or in any combination of one or more units in oiltight enclosures. A flexible diaphragm, not affected by oil or cutting fluids, is inserted between button and contact block (see diagram at left) to prevent oil seepage into the contacts.

The silver alloy contacts are maintenance free. For complete information on the Bulletin 800T line, send for the new Allen-Bradley Handy Catalog.

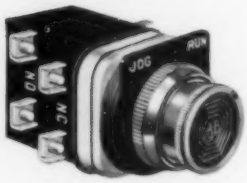
Allen-Bradley Co.
1316 S. Second St.
Milwaukee 4, Wis.



Type BA Stop Button



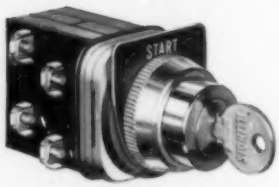
Type H2B Selector Switch



Type K2B Jog Button

Type 6PX Pendent Control

Bulletin 800T Type 2TA in Two-button Oiltight Enclosure



Type E11B Cylinder Lock Button

Type P26 Pilot Light

ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

7-54-R

GUY-WIRE GUARDS

made from

Cold-Formed Shapes

Sturdy guy-wire guards, made from Bethlehem Cold-Formed Shapes, are doing heavy duty along thousands of miles of telephone lines throughout the country. The guard is furnished to the customer formed and punched, ready for fittings.

Guy-wire guards are only one example of the growing variety of parts and products made from Bethlehem Cold-Formed Shapes. Manufacturers in widely separated fields are continually coming up with new ways of using these versatile shapes to good advantage.

Bethlehem Cold-Formed Shapes are made from steel sheets, strip or plates. Users like their uniform thickness and excellent strength-weight ratio. What's more, Cold-Formed Shapes mean lower fabricating costs because they handle, weld and assemble so readily. We make them on presses, brakes or rolls in all gages from 5 to 24.

In analyzing your shop operations, perhaps you'll find a new use for Cold-Formed Shapes. Bethlehem engineers will be glad to explain in detail the economies and other advantages of Cold-Formed Shapes, and to discuss their application to your product. Please write or phone the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

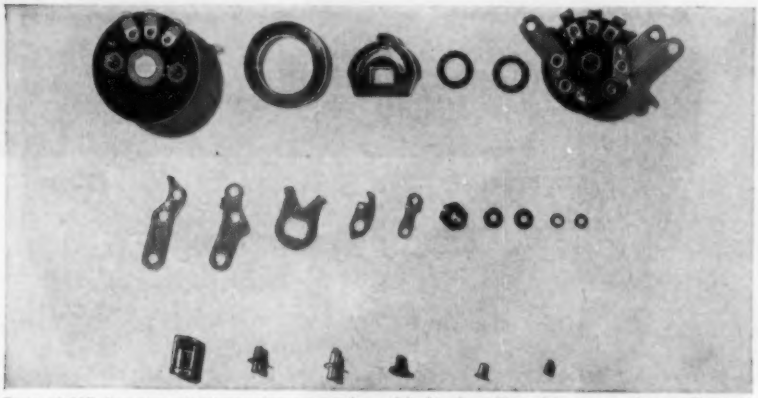
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Parts of ¼" diameter miniature volume controls used in hearing aids and in many other applications. Courtesy of Centralab, a Division of Globe-Union Inc., Milwaukee, Wisconsin.

Copper Alloys Play Important Role In Miniaturization Trend

Throughout the electronics industry, the trend is to smaller, lighter, more compact assemblies. Hearing aids, for example, must incorporate all the elements of a radio amplifier in a package not much larger than the average cigarette case. Portable communications equipment like radio sets for aircraft and automobiles, miniature personal radios, walkie-talkie units, airborne radar receivers all must be designed so that every possible extra inch of space and ounce of weight can be trimmed off the finished product.

Miniature Volume Control

Illustrated above with its copper-base alloy components is a volume control no bigger in diameter than a dime. This type of control has a rating of 1/10 watt and is obtainable with resistance ranges of from 0 to 500 ohms and on up through 10 megohms. It is probably one of the smallest volume controls commercially available. It is currently being used as a component in many hearing aids, test instruments, miniature radios, microwave sets and other miniaturized apparatus.

Copper-Base Alloys Excellent for Precision Parts

Copper-base alloys are preferred for many electrical and electronic applications because of their fine properties. Conductivity, good corrosion resistance, ability to withstand severe forming operations, high wear resistance, excellent plating and finishing properties explain their wide use in the many thousands of products with which we are familiar.

Many of the parts in this control are made of brass. Some are plated with either nickel or cadmium for increased wear resistance or silver for improved contact characteristics.

Among the parts made from brass rod are the contact blade pivot pin, the mounting studs, the shaft, rivet, hex screw and nuts. The terminals were made from yellow brass strip which is easily stamped and formed. The spacers and washers were also made from brass.

Phosphor Bronze Vital in Electronics Equipment

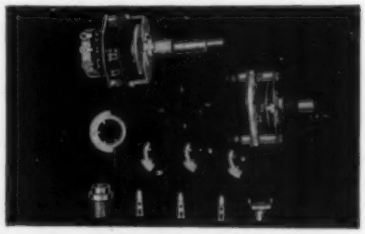
In complex assemblies like these volume controls and switches, satisfactory performance depends on each tiny part, especially those spring parts used in making mechanical and electrical contacts. For this reason, the selection of the correct alloy, temper, and gauge is most important.

The contact spring washer and spring pivot pin washer in the tiny volume control illustrated were made of Phosphor Bronze Grade C, approximately 92% copper, 8% tin, and 0.1% phosphorus. Supplied for these applications 8 B&S numbers hard, the material has a tensile strength of about 112,000 psi. It is widely used throughout the electronics industry because it combines superior spring properties as well as conductivity and high corrosion resistance.

Parts like contact springs must have high fatigue resistance to withstand millions of flexing cycles. Spring washers must withstand constant compression without taking a set if they are to be satisfactory. They must also be corrosion resistant under all climatic conditions. Phosphor Bronze meets all these qualifications and yet can be stamped and formed into precision parts. That is why Phosphor Bronze is in such wide use in the fields of radar, radio, television, sound reproduction and amplification, and in all types of electronic and electrical equipment and controls.

Bridgeport Brass Service

Bridgeport Brass supplies copper-base alloys—in strip, rod, tubing, and wire—used in the electronics field. Our Laboratory will be glad to assist you in the selection of proper alloys for your applications. Write for Bridgeport Brass Technical Handbook for properties and applications of copper-base alloys. Call or write the Bridgeport District Office nearest you. (714)



Parts of electronic switch and assembled switches. Courtesy of Centralab, Milwaukee, Wisconsin.

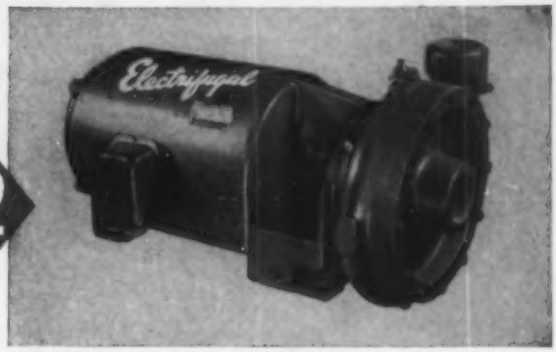
ALLIS-CHALMERS

PUMPS for Designers

3 Ways to Save

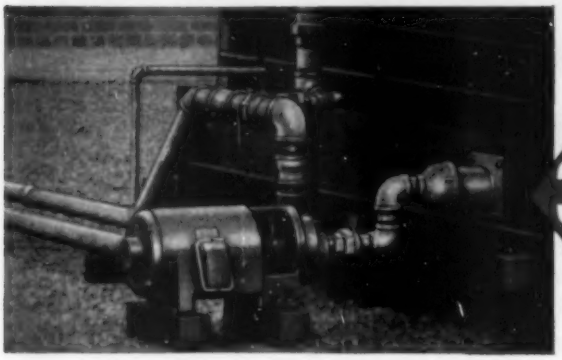
SAVE ENGINEERING TIME

Allis-Chalmers representative will sit down with you in the planning stage and help you design the best possible pump set-up at the lowest cost. A-C field engineers will save you much costly engineering work and *guarantee* the complete pump and motor unit.



SAVE—NO EXTRA PARTS TO BUY

Designed as a complete, compact unit, Allis-Chalmers close-coupled pumps don't require extras — such as couplings, bases or shims. The pumps come as units ready to hook up and run!



SAVE ON INSTALLATION TIME

Bolt it down, hook up the line and piping, and your Allis-Chalmers pump is ready to go. There's no alignment problem. Correct installation is a big factor in pump performance and the A-C engineer will advise you at this point.

For more information about Allis-Chalmers designers' pumps, write for bulletins 52B6140, 52B7529, 52B6083 or 52B6975.

ALLIS-CHALMERS, Milwaukee 1, Wisconsin

FHP PACKAGE PUMP

Standard with mechanical seal. Widely used and accepted for air conditioning and refrigeration.

Bulletin 52B7529

***ELECTRIFUGAL* PUMP**

A close-coupled pump with either conventional packing or mechanical seal.

Bulletin 52B6140

SUPPORTING ADAPTER PUMP

Flange motor and pump on sturdy supporting adapter. With conventional packing or mechanical seal.

Bulletin 52B6083

VERTICAL MOUNTED PUMP

Mechanical seal or sealless units with choice of submerged or sidewall mounting.

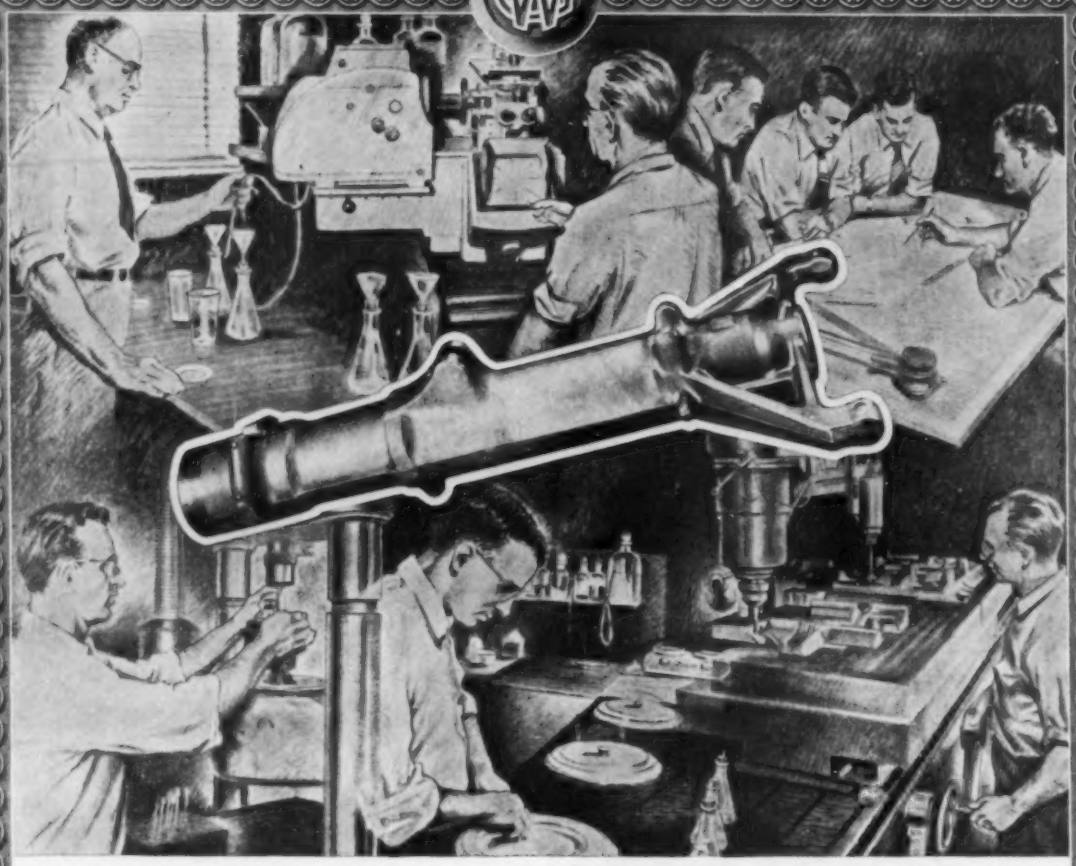
Bulletin 52B6975

Electrifugal is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4228



FORGING TECHNICIANS—Yes, that is the compliment paid us by those acquainted with our services. In back of each design is a thorough understanding of engineering and metallurgical needs before production begins . . . assuring forgings of maximum physical properties and uniform quality.

THE LANDING GEAR FORGING illustrated, nearly five feet long, is an important component for a modern military fighter . . . another example of Wyman-Gordon's technical contribution to aircraft.

There is no substitute for Wyman-Gordon experience

WYMAN-GORDON

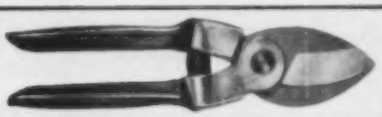
Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

✻ **DOOR GUARD IS EXTRUDED** plastisol based on BAKELITE Vinyl Dispersion Resins. Fastened to stile and jamb, the plastic stripping covers the usual gap at butt side of door . . . prevents mashing of fingers. Though this strip flexes and stretches hundreds of times a day, it won't crack or distort. It defies weather and sunlight without deteriorating or fading. By *The Stanley Works—Magic Door Division*—New Britain, Conn.



SLIP-PROOF GRIPS are made by dip-coating shear handles in plastisols made of BAKELITE Vinyl Dispersion Resins. The firm, cushioning grips hold fast to metal . . . won't crack or peel in hard use. Tough and resilient, they resist abrasion, twisting, distortion . . . defy oil, grease, chemicals, water. By *H. K. Porter Inc.*, Somerville, Mass.

FISHERMEN BENEFIT from this improved nylon tapered line coated with plastisols made of BAKELITE Vinyl Dispersion Resins. The lightweight plastic coating needs no treatment . . . yet will not absorb water while floating on the surface. It also protects against excess wear, giving the taper longer life. By *Sunset Line and Twine Co.*, Petaluma, Calif.

✻ **PROTECTIVE PLASTISOL COATING** prevents galvanic corrosion between copper and aluminum conductors in the electrical connector. Plastisol coating based on BAKELITE Vinyl Dispersion Resins seals out air and moisture . . . withstands ravages of weather to ensure long connector life. By *Burndy Engineering Co., Inc.*, Norwalk, Conn.

Cut production time . . . boost sales appeal

Take a look at these diverse products. Each uses fluid, fast-curing plastisols based on BAKELITE Vinyl Dispersion Resins differently. Each benefits in added sales appeal and ease of production by the many useful properties of these easy-working materials.

No special equipment is needed to fabricate these plastisols. They adapt to slush-molding, extrusion, dip-coating or pouring. They form under little or no pressure . . . cure at 350 deg. F.

Plastisols based on BAKELITE Vinyl Dispersion Resins are extremely faithful to intricate mold details. They give you a choice of either dull or glossy finishes. And any color can be obtained simply by adding pigment.

The finished products are tough and flexible. Plastisols based on BAKELITE Vinyl Dispersion Resins resist abrasion, cracking, distortion and automobile engine heat. They defy strong chemicals, soaps, oils, greases and corrosive atmospheres. Their excellent dielectric qualities are another major selling point. For the full story of BAKELITE Vinyl Dispersion Resins, write to: Dept. XY-10.

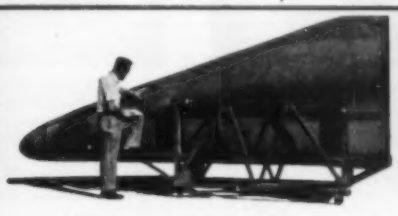
BAKELITE
TRADE-MARK
VINYL DISPERSION RESINS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

Data courtesy of **Stanley Chemical Company**, East Berlin, Conn.

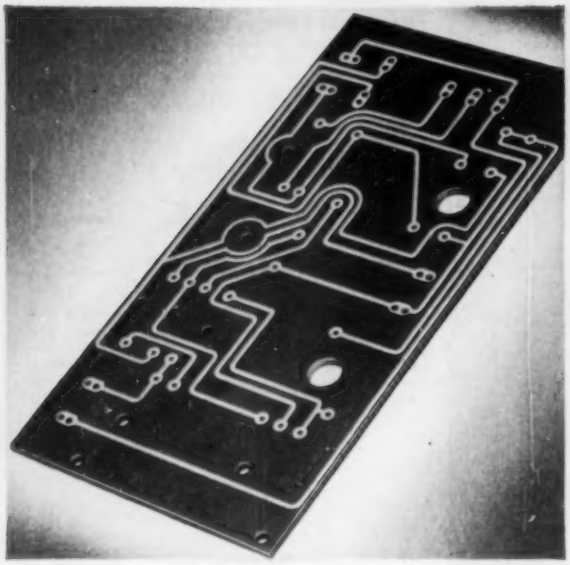
SHELL MOLDS made with BAKELITE Phenolic Resins are light in weight, speed handling. Accurately reproduce pattern details, cut machining and finishing. Can be stored to meet future production schedules. Made by The Cooper Alloy Foundry Co., Hillside, N. J.



80% SAVING in construction costs resulted from use of reinforced plastics—BAKELITE Polyester Resins and glass cloth—for this Navy bomber stinger tail. Seventeen feet long, it carries submarine detection devices. Made by Zenith Aircraft, Div. of Zenith Plastics Co., Gardena, Cal.

WASTEBASKET molded of BAKELITE Polyethylene is tough, resilient, lightweight. Won't dent if dropped. Washable in soap and water. Comes in a variety of opaque colors. Resists chemicals, most acids, and alkalies. Made by Loma Plastics, Inc., Fort Worth, Tex.

How would YOU solve these two problems?



1. PRINTED CIRCUITS have become vital in the new, miniaturized electrical and electronic devices. For etching these circuits, temperature of the acid bath must be accurately controlled. The Master Etching Company of Wyncote, Pa., has developed an automatic temperature control unit for this important purpose. The heat element is built into a pyrex tube, while its dependable THERMOSWITCH® is enclosed in flexible plastic tubing. The whole assembly is then encased in an acid-proof container.

2. HOW CAN COMMERCIAL, industrial, hospital and diaper laundries insure continued and better customer satisfaction? One solution is to employ devices using Fenwal THERMOSWITCH units. Henrici HT-1 and -2 Timers accurately control temperatures of washing formulae. Henrici tumbler Door Openers open tumbler doors, protecting goods being dried from scorching. Fenwal THERMOSWITCH units have been used in these devices for over ten years.

3. ARE YOU USING FENWAL THERMOSWITCH CONTROLS to solve your problems? Compact, highly resistant to shock and vibration, these controls have solved a wide range of temperature control problems. Their external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts.

4. SEND FOR THIS CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 27 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE . . . *but only to heat*

Order your size of TIMKEN® 52100 steel tubing today—we'll ship from mill stock tomorrow!

101 sizes of Timken® 52100 steel tubing are available in mill stock to take care of your rush hollow parts jobs. Order your size in less-than-mill quantities today, and we'll ship within 24 hours.

Timken 52100 steel tubing is excellent for most of your high quality hollow parts jobs. It's a through-hardening steel in moderate sections. It can be heat treated to file hardness and tempered back to any desired point. And it can be used in place of more expensive steels.

Available in sizes from 1″ to 10½″ O.D., Timken 52100 steel is used for hollow parts jobs like these: aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts, precision instruments, and dozens of other jobs.

The Timken Company is America's pioneer producer of 52100 tubing. And we're the only company that makes 52100 steel in tubing, bars and wire. Our unequaled experience assures you of uniform quality from tube to tube and heat to heat.

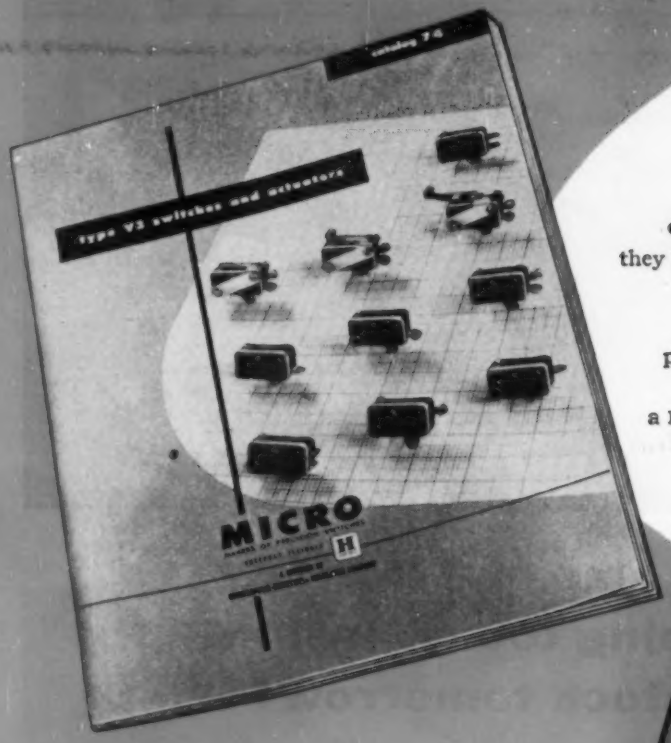
For immediate delivery of your less-than-mill quantity orders, write, wire or phone The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

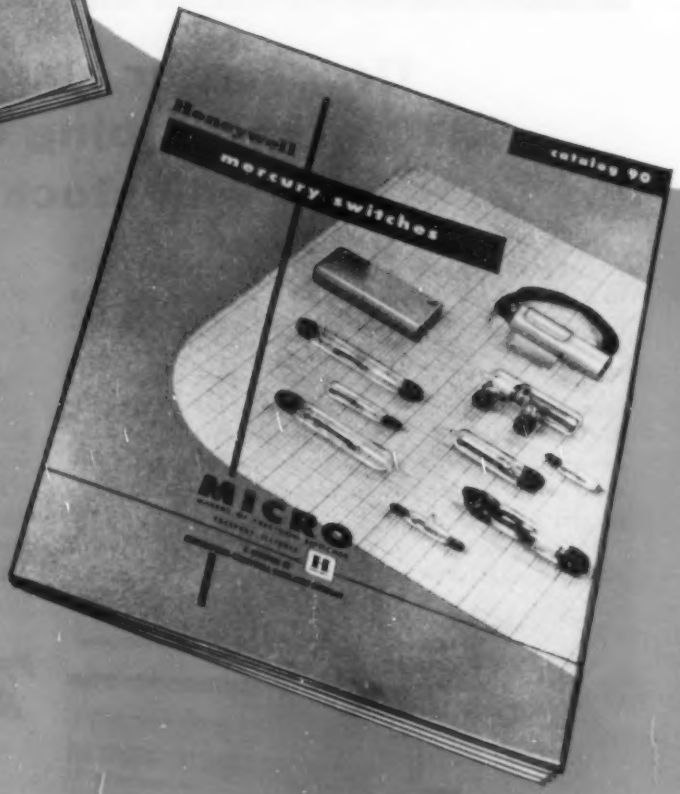
Why MICRO to your solution of



1 • A WIDE VARIETY TO CHOOSE FROM

• Industrial designers save time and money when they bring switch design problems to MICRO SWITCH.

For almost two decades MICRO SWITCH has pioneered the development of new and better precision switches to meet every type of industrial need. There is now—or can be developed—a MICRO SWITCH product that will meet your most critical design requirements—enhance the value of your products.



• Easy selection of the MICRO SWITCH precision switch that best fits your needs is further simplified by the variety of MICRO SWITCH catalogs. These picture and describe the characteristics of specific groups of switches. Shown here are informative catalogs on the ultra-small V-3 switches and the HONEYWELL mercury switches.

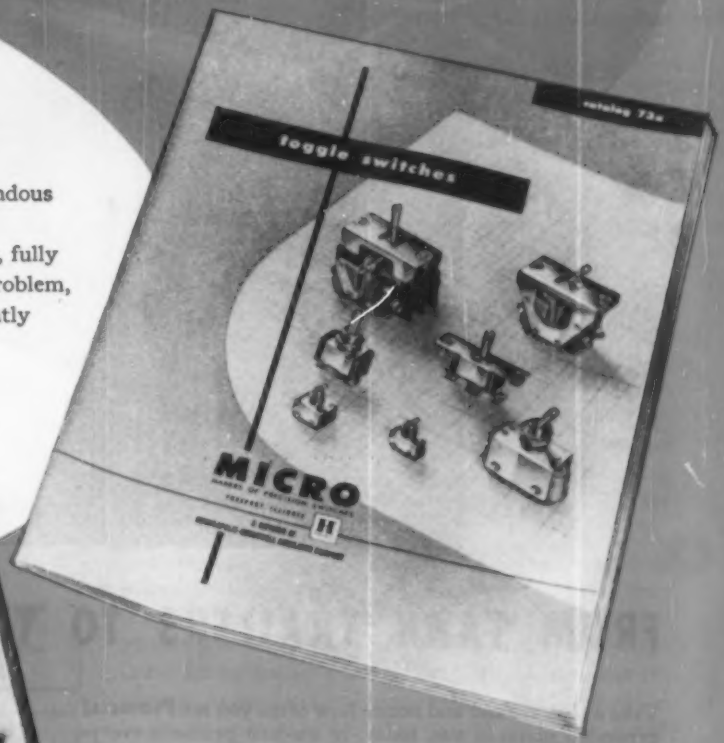
A complete line of precision snap-action and mercury switches

SWITCH is the short cut switch design problems

2 • ENGINEERING AID IN SWITCH SELECTION

• Selection of the exact switch from the tremendous reservoir of MICRO SWITCH developments is quick and easy. MICRO SWITCH field engineers, fully experienced in every type of precision switch problem, are as close as your telephone—at 16 conveniently located branch offices. There is no obligation.

MICRO SWITCH products provide extreme uniformity and reliability of performance—in most cases, longer switch life than you will ever need.



In the great majority of cases, the MICRO SWITCH precision switches pictured and described in these catalogs will prove completely satisfactory. If, however, present switches do not meet your requirement, MICRO SWITCH engineering, both in the field and at the factory, can develop an entirely new switch with minimum time and expense.

Let a MICRO SWITCH engineer help you select just the right precision snap-action switch or mercury switch for your application

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

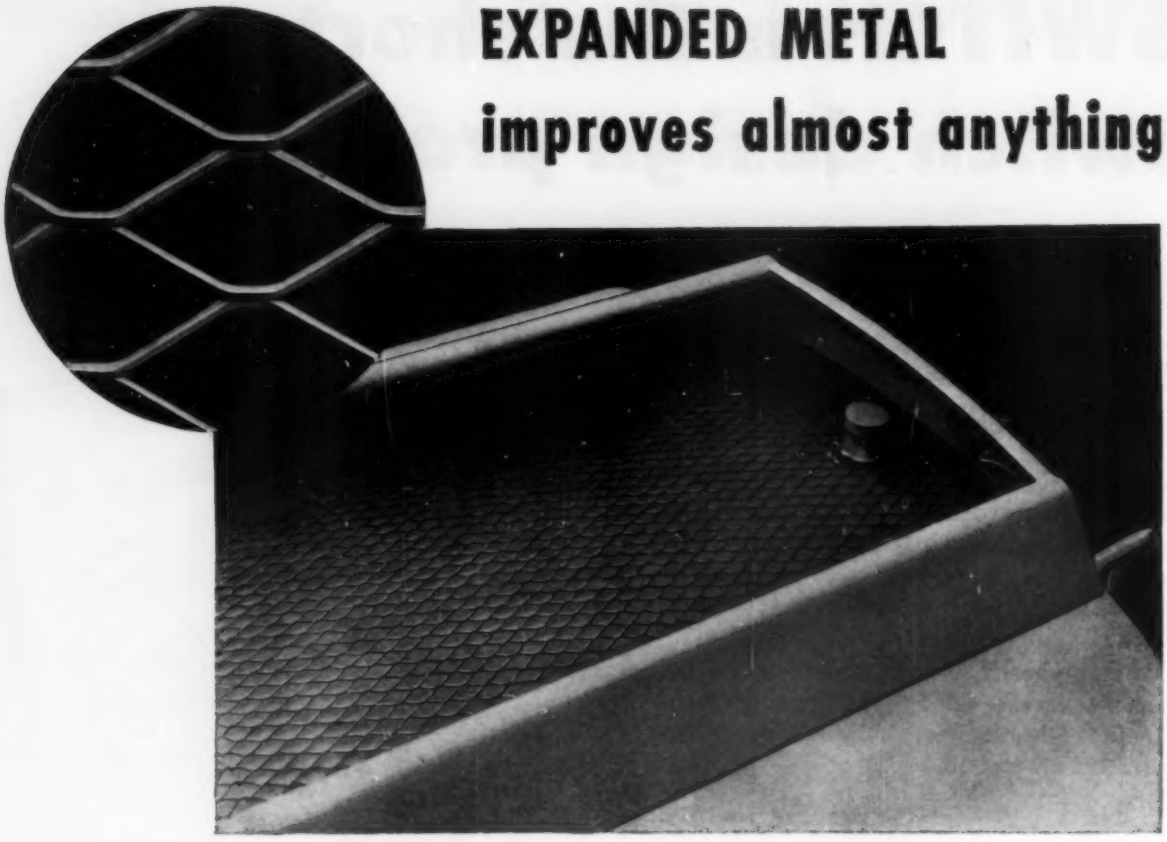
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FREEPORT, ILLINOIS

H HONEYWELL

EXPANDED METAL
improves almost anything



FROM TANK TRAILERS TO TELEVISION ANTENNAS

Take a look around and notice how often you see Penmetal expanded metal in use, today, in modern products everywhere. It is literally *the material of a thousand uses.*

Why is this material rapidly becoming a sign of good design, good engineering? Because it is strong and rigid, yet light in weight and low in cost. Because it permits free passage of light and air, and has that smart, clean, attractive appearance that typifies modern trends in design.

Penmetal expanded metal is sheet metal that has been slit and expanded to as much as ten times its original width. Up to 80% lighter than solid sheet of the same dimensions, the diamond truss pattern adds rigidity and strength.

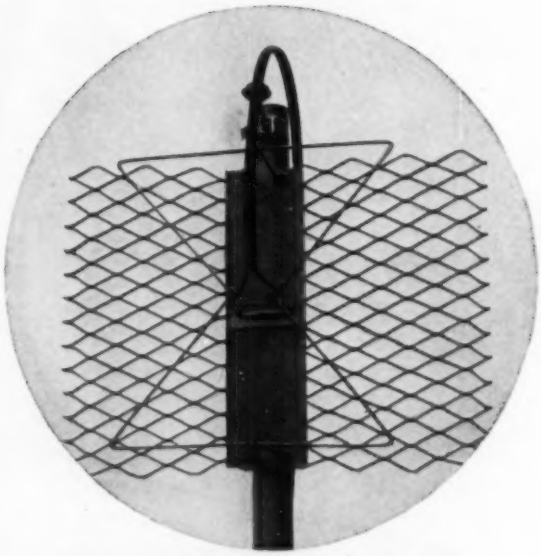
Available in corrosion-resistant metals as well as carbon steel; large or small mesh; light or heavy gauge. Easily formed, shaped and welded.

Send for *NEW* 28-page catalog which gives mesh sizes, weights and dimensions, and shows many profitable ways in which you can use Penmetal expanded metal. No cost or obligation.

PENN METAL COMPANY, INC.

General Sales Office: 205 East 42nd Street, New York 17, N. Y.

District Sales Offices: Boston, Philadelphia, Parkersburg (W. Va.), Detroit, Chicago, Dallas, Los Angeles, San Francisco, Seattle



The tank trailer, made by Trailmobile, Inc., Cincinnati, Ohio, uses Penmetal expanded metal for walkway.

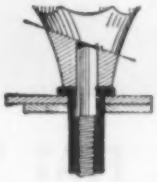
Penmetal expanded aluminum is used for the television antenna manufactured by The Radiart Corporation of Cleveland, Ohio.

PM-34

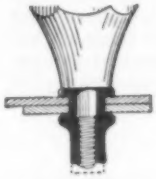
B. F. Goodrich RIVNUTS give new way to fasten leveling feet... cut costs!

Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



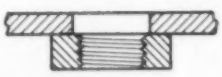
3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

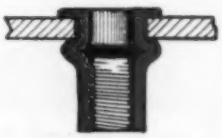
Compare these 4 methods of putting screw threads in thin sheet metal

Tapped—2 threads

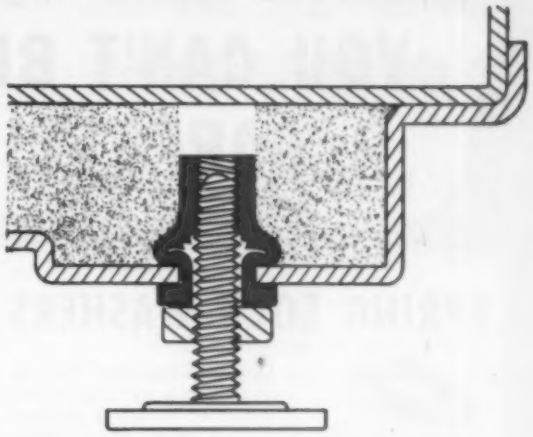
Pierced and tapped—3 threads



Projection welded—4 threads



Rivnut—at least 6 threads



APPLIANCE DESIGNERS were looking for a way to fasten leveling feet to the bottoms of refrigerators, stoves and automatic washers. The metal was too thin to tap, and welding would warp it. Besides, the threads would be ruined in the enameling process.

All these problems were solved by a B. F. Goodrich Rivnut—the *only* one-piece blind rivet with threads! Working from one side of the cabinet, one man installs the Rivnut in a few seconds. The easy-to-use power heading tool forms a bulge in the Rivnut shank—a "second head" that tightly grips the material. At least six threads remain clean to take the leveling-foot screw—more than enough to take the heavy loads. Installation is made *after* enameling without marring the finish.

Besides these advantages, the quick, simple installation of Rivnuts saves time, cuts assembly costs. For help on your fastening problem, write The B. F. Goodrich Company, Dept. PE-74, Akron, Ohio.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-74, Akron, Ohio.

B.F.Goodrich RIVNUT *The only one-piece blind rivet with threads*

If You Need

SMALL PARTS IN A HURRY

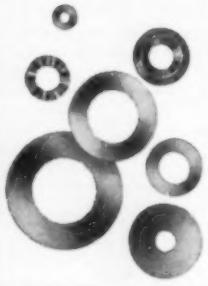
plus sound engineering service

YOU CAN'T BEAT GARRETT!

SPRING LOCK WASHERS

Garrett Controlled Tension spring lock washers assure greater holding power, longer life of every assembly. Garrett makes a complete line of lock washers to ASA and SAE specifications, plus many special types . . . in all metals and plated to your requirements.

FLAT WASHERS



Garrett gives you fast delivery from stock on the largest line of flat washers available. Precision-made in thousands of different sizes and types—standards and specials. Also made to your exact specifications to meet the individual needs of your product.

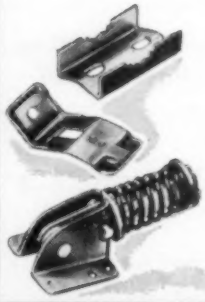
HOSE CLAMPS

AN 737 . . . stainless steel, radial type with floating bridge and thumb-screw adjustment. Approved for aircraft use.

QS-100 & AN-748 . . . worm-type, self-locking screw. Plated to prevent corrosion. Approved by Armed Forces.

AUTO-SEAL . . . screw-type adjustment, scarfed tongue prevents pinching. Staked bolt and captive nut. Rustproofed.

STAMPINGS



Quick deliveries on small and medium stampings made to your specifications on automatic, high-speed precision presses. Finishing equipment includes tumbling, polishing, heat treating and plating.

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DELCO MOTORS

the best running mate your product can have

There are millions of Delco motors —fractionals and integrals—now serving reliably to operate appliances, tools, machinery and equipment of every sort.

Such universal approval suggests that a Delco motor gives a good account of itself, performance-wise. Such universal approval suggests, too, that a Delco motor would make the best running mate for *your* product!

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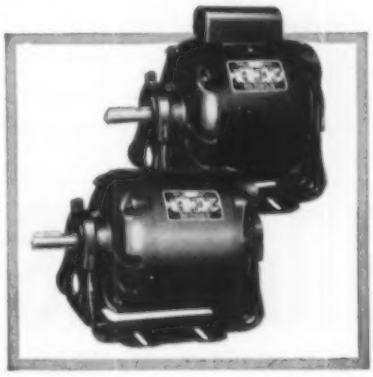
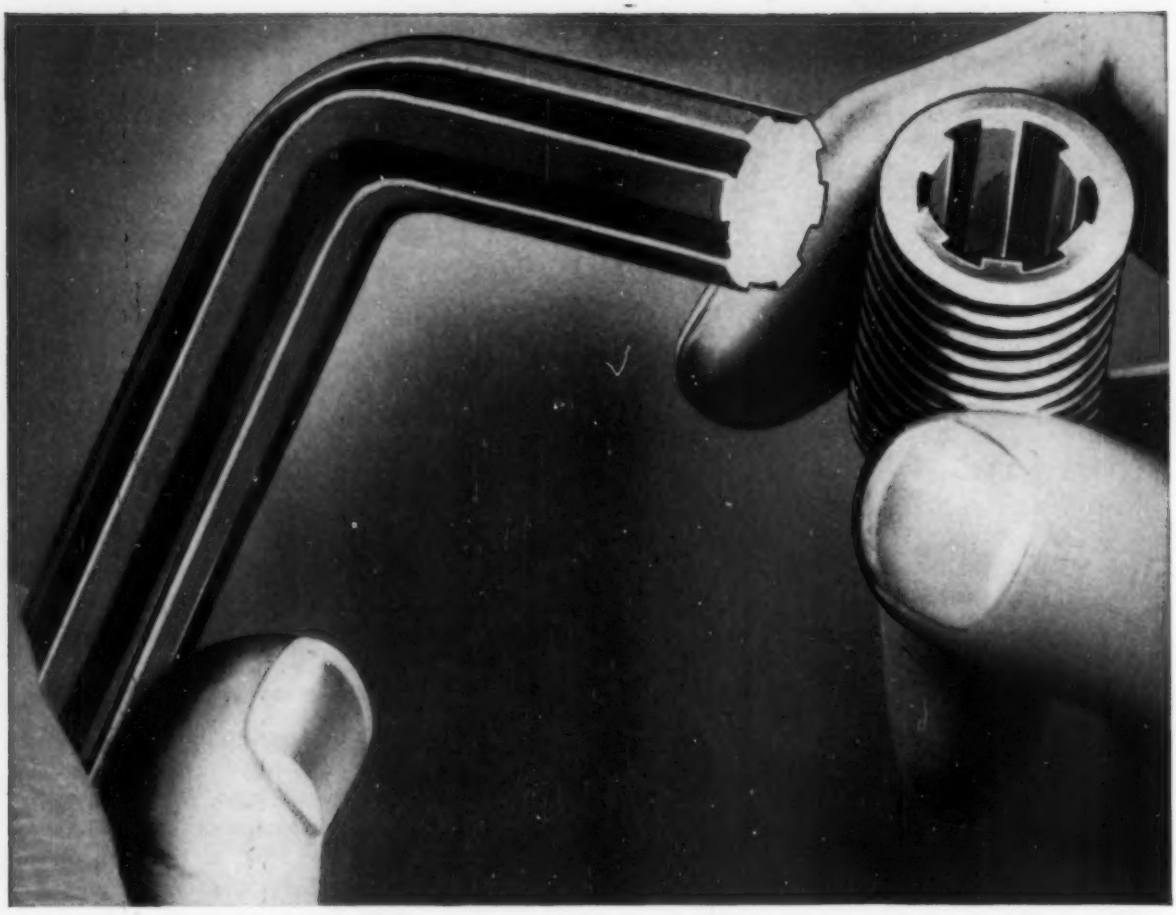




Multiple-Spline Set Screws hold tighter— because you can wrench them tighter!

The extra holding power of Bristol's exclusive multiple-spline set screws enables these flush-fitting fasteners to be used in the newest, most compact design applications.

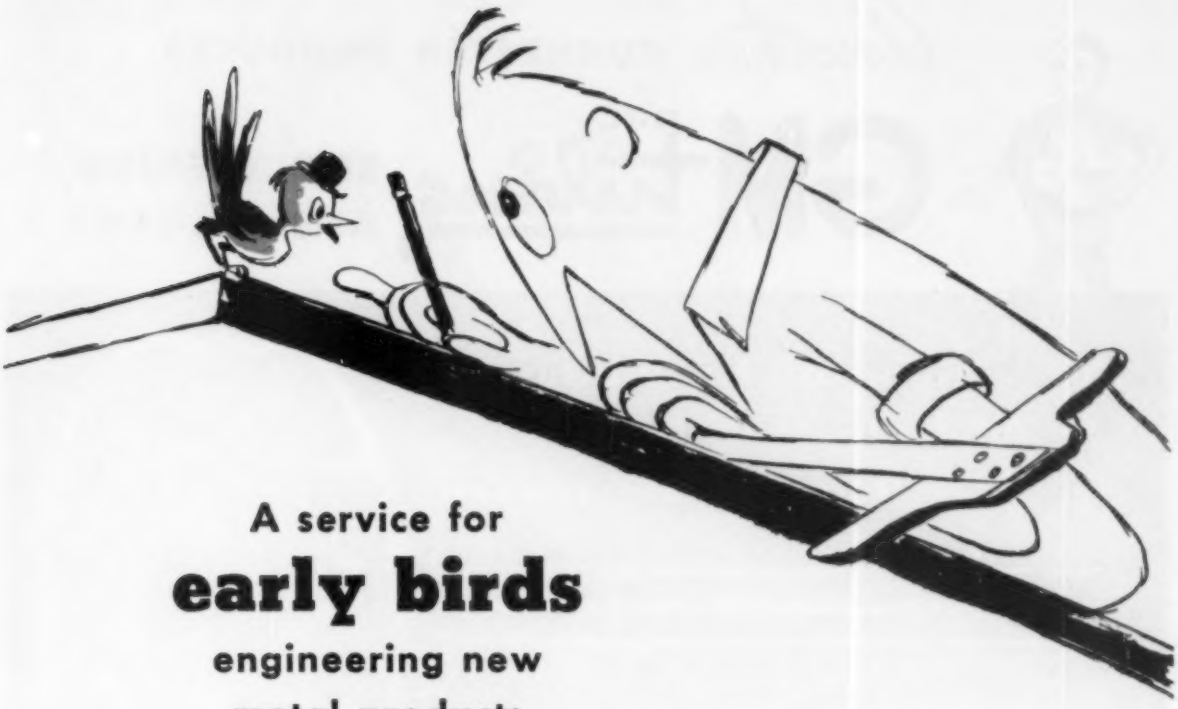
They withstand severe shock and vibration, permitting fewer and smaller screws to be used without sacrificing strength.

While the splining principle has long been recognized as the best means of transmitting rotary power, the materials of which they are made also contribute to the tremendous holding strength of these Bristol set screws. Standard screws are made of heat-treated alloy steel; bronze, brass, monel or other metals are available on special order.

Bristol multiple-spline set or cap screws are carefully designed to close tolerance (ASA approved) in sizes from 0 wire to ½" in diameter. Get them through your regular industrial distributor.

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.



A service for
early birds
engineering new metal products

...early birds
are sheet metal design engineers and production men who make a point of getting the gremlins out of new products or new models in early stages...

Here's a new service that will appeal to you – if you count yourself an EARLY BIRD.

First, National Lead's Tool & Stamping Department engineers go over your designs with you, scouting possible production bugs and ways to cut costs.

Then, National Lead casts try-out tooling for you in "Kirksite" A or "Nalcolite" plastic . . . stamps out the parts in the stock you specify . . . assembles pilot models if you want . . . and refines detail in dies, parts and pilot models until they're proved to your satisfaction.

All this accomplished, the try-out tooling goes to you for medium-run production or for duplication in steel for very long run tools.

With this Tool & Stamping Department service you have the gremlins out well before full scale production is set to roll. So if you have a new product or new model coming up, do as other EARLY BIRDS are doing, write:

National Lead Company

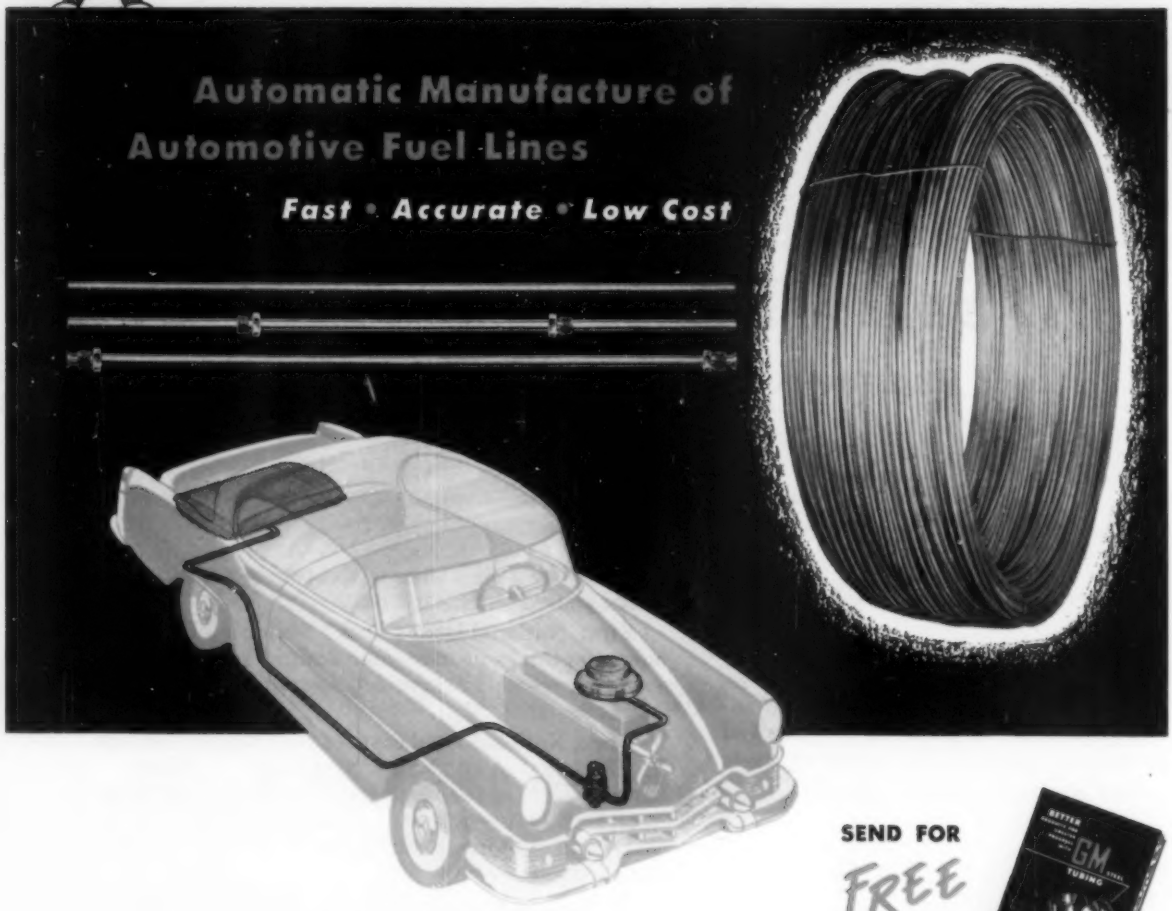
900 West 18th Street
Chicago 80, Illinois

TOOL & STAMPING DEPARTMENT

Another ROCHESTER PRODUCTS

GM STEEL tubing

ENGINEERING ACHIEVEMENT



FROM the initial long-length coil of GM Steel Tubing to the final intricately formed product, complete with fittings and flared ends, the manufacture of Rochester Products *automotive fuel lines* is virtually *automatic.* Ingeniously designed machines assure *better, faster* production . . . effect *savings* that are *passed on* to the buyer!

This is a typical example of how Rochester Products engineers combine ideas, skill, experience and GM Steel Tubing to help hundreds of industries build *better products* for *less money.* Why not find out now how we can help *you?*

SEND FOR *FREE* BROCHURE

Entitled *"Better Products for Greater Progress . . . ,"* this new, illustrated, fact-packed brochure tells how GM Steel Tubing can help solve design, production and cost problems. Send for your free copy today.

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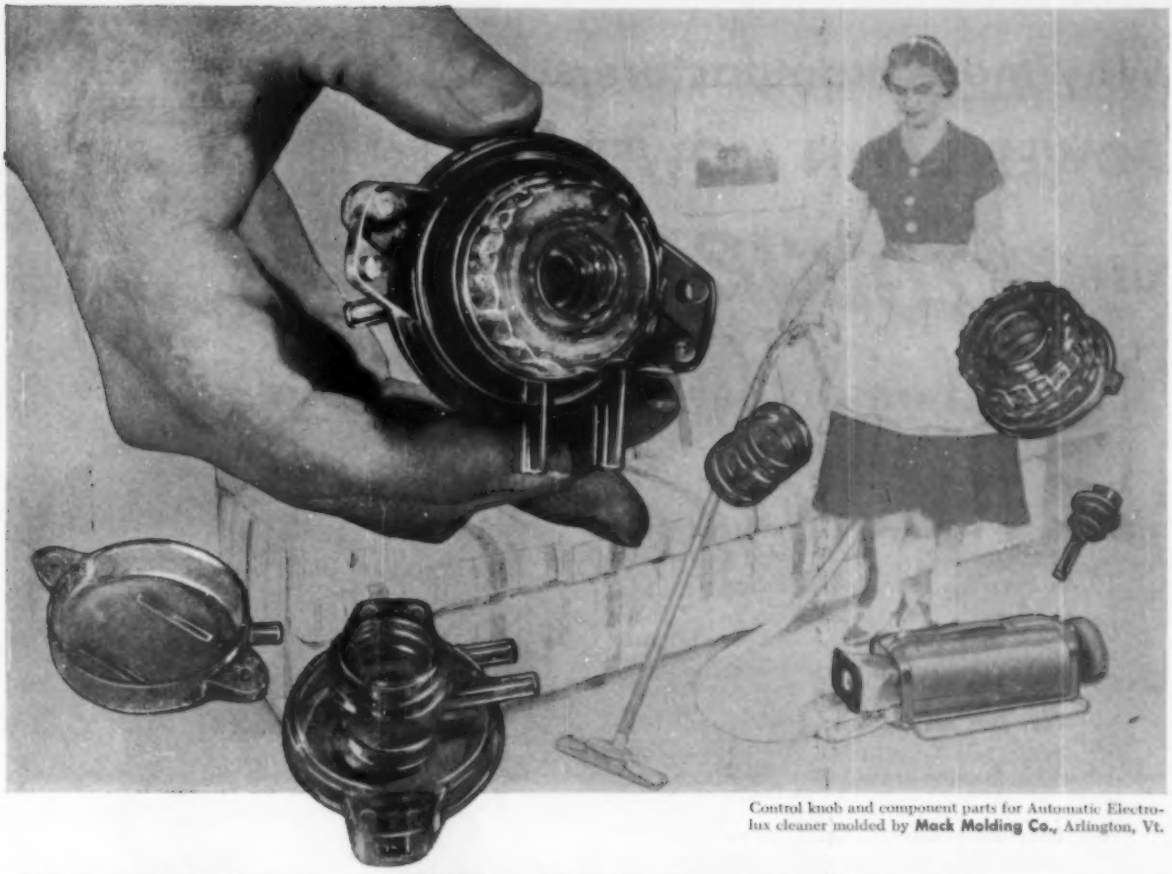
RP GM STEEL TUBING

ROCHESTER PRODUCTS DIVISION OF GENERAL MOTORS

ROCHESTER, N. Y., U. S. A.

ALSO MANUFACTURERS OF ROCHESTER CARBURETORS AND ROCHESTER CIGAR LIGHTERS



Control knob and component parts for Automatic Electrolux cleaner molded by **Mack Molding Co.**, Arlington, Vt.

PLASTIC DIAL TUNES IN A NEW SELLING POINT

You turn this plastic dial knob on the new Automatic Electrolux vacuum cleaner to adjust the cleaner for the dirt condition of the locality in which it is to be used. When collected dirt threatens to lessen air flow, an automatic "brain" stops the motor and ejects the paper dust bag, sealed and sanitary. Put in a new self-sealing bag, and the cleaner runs with full power.

The knob and its component parts that set the automatic "brain" are molded from BAKELITE C-11 Plastic, an acrylonitrile-styrene copolymer. This plastic has good impact strength, withstands heat, and is resistant to oil and most chemicals.

BAKELITE C-11 Plastics are readily molded into intricate, accurate working parts. Their dimensional stability is excellent. They can be sawed, milled, drilled, tapped. They have excellent resistance to soaps, detergents, most acids, alkalies, foods, and fruit stains.

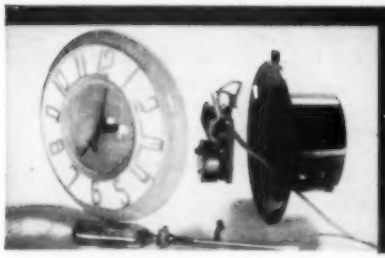
That's why so many industrial and consumer items can be improved in design, sales and service through their use. Learn how they can fit your product by writing Dept. XP-10.

BAKELITE
TRADE-MARK
C-11 PLASTICS

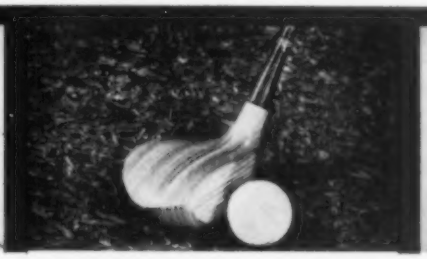
TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

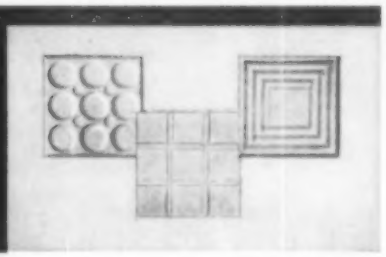
In Canada: Bakelite Company
Division of Union Carbide Canada Limited
Belleville, Ontario



FACE AND COVER for electric clock are BAKELITE C-11 Plastic, an acrylonitrile-styrene copolymer. Finely detailed, tough, brilliantly colored, they combine structural and decorative functions. Molded by Telechron Dept. of General Electric Co., Ashland, Mass.

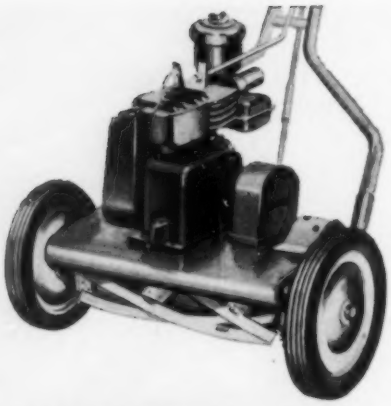


EXTRA-STRONG CLUB HEADS are carved from densified wood produced by forcing BAKELITE Phenolic Resins into wood cells. They resist moisture, temperature change, shrinking, cracking. Need no coating. Made by Albert S. Liebers Co., New York 7, N. Y.



TRANSLUCENT CEILINGS made from these formed BAKELITE Rigid Vinyl Sheet panels are suspended below fluorescent fixtures, diffusing glareless light throughout room. Light weight permits easy removal for cleaning. Made by Daylight Ceiling Co., San Francisco 7, Calif.

Why more manufacturers of POWER LAWN MOWERS use KLOZURES* than any other oil seal!



1. **They're uniform**—both in sealing contact and in spring load. KLOZURES are precision made to the highest standards of accuracy.

2. **They save space**—these seals are compact and light in weight, yet they're rugged.

3. **They give positive bearing protection**—KLOZURES seal the lubricant in *and* keep dust, dirt and water out.

4. **They save money**—made in radial widths smaller than conventional oil seals and with fewer parts.

Model 93-B—A narrow cross-section seal with synthetic rubber outer covering for soft metal housings.

Model 71A—A narrow cross-section springless seal for grease retention and dirt exclusion.

Model 71-B—A narrow cross-section spring-loaded seal for either light or heavy lubricants.

Leading manufacturers of power lawn mowers and power lawn mower engines know they can depend on Garlock KLOZURE oil seals for maximum bearing protection under rugged service conditions. Engine manufacturers use KLOZURES on the output shaft. Power lawn mower makers use Garlock KLOZURES to protect bearings on wheels, reels and gear boxes.

Let us show you how Garlock KLOZURE oil seals can prolong the life of your bearings. There's a service-tested KLOZURE model for every bearing application. Get all the facts —call your GARLOCK representative or write for KLOZURE Catalog No. 10.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

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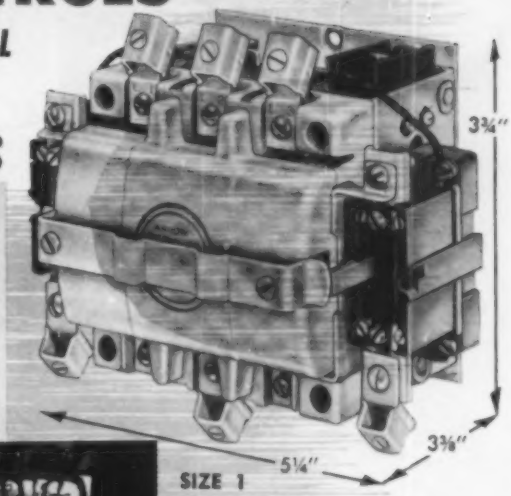
GARLOCK

PACKINGS, GASKETS, OIL SEALS
MECHANICAL SEALS
RUBBER EXPANSION JOINTS

Radically Smaller

ADVANCED DESIGN MOTOR CONTROLS HELP THIS NEW AIRFOIL MILLING MACHINE SMASH DEFENSE BOTTLENECKS



SIZE 1

The Model 102 Airfoil Milling Machine, developed and manufactured by the New England Machine and Tool Company of Berlin, Conn., is sold exclusively through Pratt & Whitney Division Niles-Bement-Pond Co. of West Hartford, Conn.

Replacing previous hand methods, this ingenious new machine mills the original, 3-dimensional masters from which turbine blades for jet aircraft engines are manufactured. Reliably accurate masters . . . precision machined and faired to the designers' exact specifications . . . are now produced in ***hours*** where weeks of laborious bench work were once required. Another dangerous bottleneck in our vital defense effort is broken.

Complexity of the operating components in the Model 102 Milling Machine placed a premium on space . . . and space had to be found for 4 across-the-line starters and 1 reversing starter. Bulky controls of conventional design would necessitate a much larger control cabinet and interfere with the machine's easy accessibility from both sides necessary for set up purposes.

Space-saving Arrow-Hart Controls were easily fitted into the machine base. Lighter weight made it practical to mount all 5 starters on an unusually compact door-back panel (with plenty of space left for easy wiring) that swings out for instant accessibility. And these A-H Controls also assure the added benefits of superior performance, greater dependability and longer life.

YOUR ADVANCED DESIGN MACHINES . . . deserve electrical controls that will bring out the full efficiency that you have designed into them. Specify Arrow-Hart . . . you'll be years ahead.

SEND NOW FOR COMPLETE INFORMATION ABOUT ARROW-HART ADVANCED DESIGN ▶

SINCE 1890

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INDUSTRIAL CONTROL DIVISION
103 HAWTHORN ST., HARTFORD 6, CONN., U.S.A.

Offices, sales engineers and warehouses in: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco. In Canada: Arrow-Hart & Hegeman (Canada) Ltd., Mt. Dennis, Toronto. In England: Arrow Electric Switches, Ltd., Ealing, London W 5.

QUALITY MOTOR CONTROLS • WIRING DEVICES
ENCLOSED SWITCHES • APPLIANCE SWITCHES

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THE ARROW-HART & HEGEMAN ELECTRIC CO.
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☐ *Please send circular describing A-H Advanced Design Controls.*
☐ *Please send catalog covering the complete A-H Motor Control Line.*

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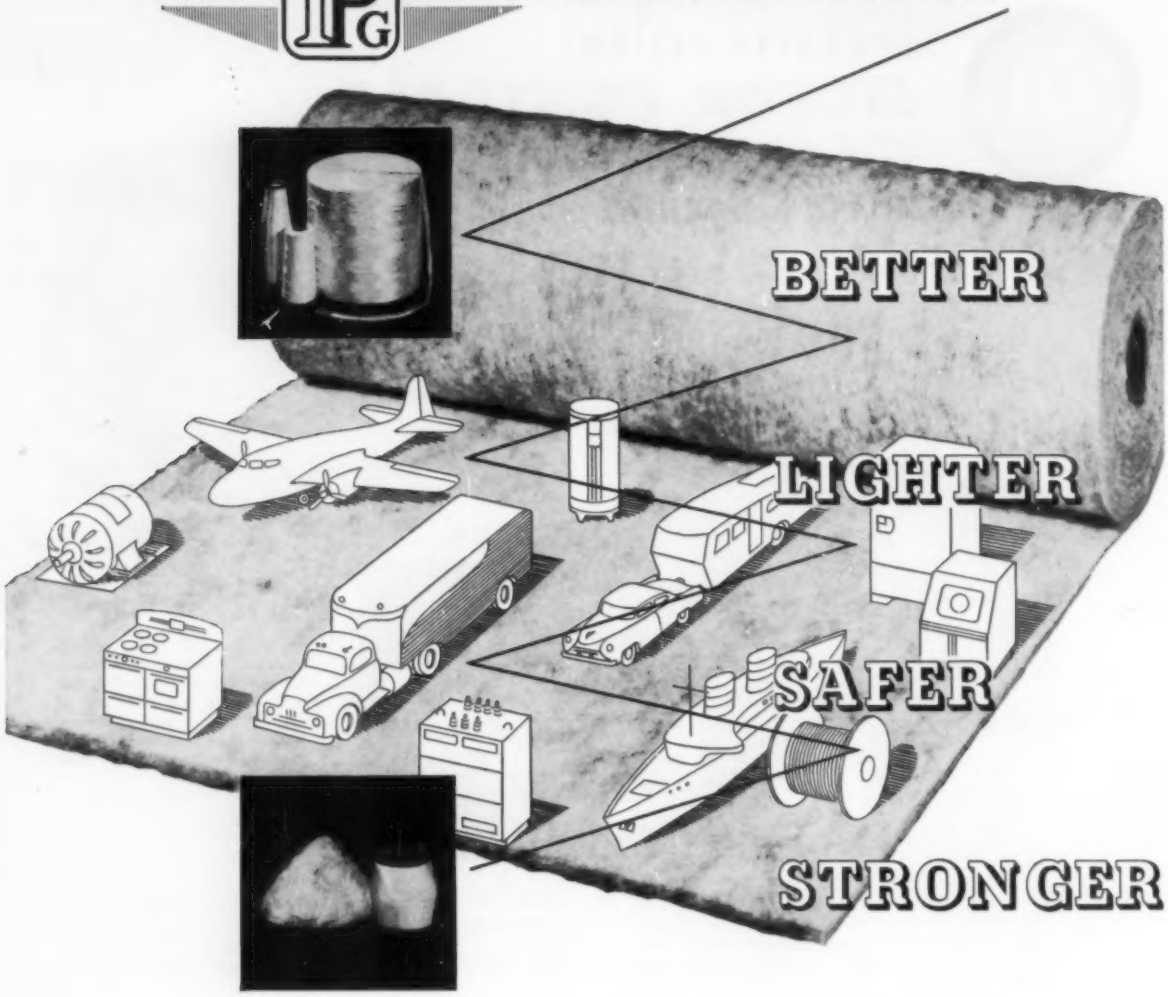
PE

FIBER PPG GLASS *HELPS MAKE PRODUCTS*



Perhaps your product needs lightweight, space-saving thermal and acoustical insulation. Or you may be interested in the strongest of all plastic reinforcements, or electrical insulations that prolong the life of apparatus, or a fiber for producing flame-proof textiles that may be as sheer or as rugged as your use requires. Pittsburgh Fiber Glass can meet any of these needs—and many more—with performance that makes products better, safer, lighter, stronger.

We'll be glad to give you complete product data and information on facilities for serving you. Technical assistance is also available. Pittsburgh Plate Glass Company, Fiber Glass Division, 420 Duquesne Way, Pittsburgh 22, Pa. District Sales Offices: Chicago, Cincinnati, Cleveland, Detroit, New York, Washington.

SUPERFINE INSULATION—"AA" and "B" fibers in a complete range of blanket roll sizes, thicknesses, densities, facings.

YARNS, ROVING and STRANDS—Made with the continuous filament process to an exceptional degree of fiber uniformity.

FIBER PPG GLASS PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

More than meets the eye

P-K Socket Screws, at a glance, may look substantially like those you buy from "habit." You have to "look *beyond* the hex" for the difference.

If you don't, you are buying with a "blind spot" that can block your way to *proved* benefits other buyers are using to advantage. Parker-Kalon's exacting Quality Control is only one of the advantages you don't see until you "look beyond the hex."

Look Beyond the Hex

Compare every detail of product and service. Compare for advanced design . . . for proved assembly strength . . . for buying aids, and supply service. Get all the facts, and try P-K Socket Screws. You'll find they take top rating in any test.

Get samples, information from your P-K Distributor, or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick Street, New York 14, N. Y.

FOR TOP QUALITY and tolerance gaged to your most exacting specifications — and guaranteed.

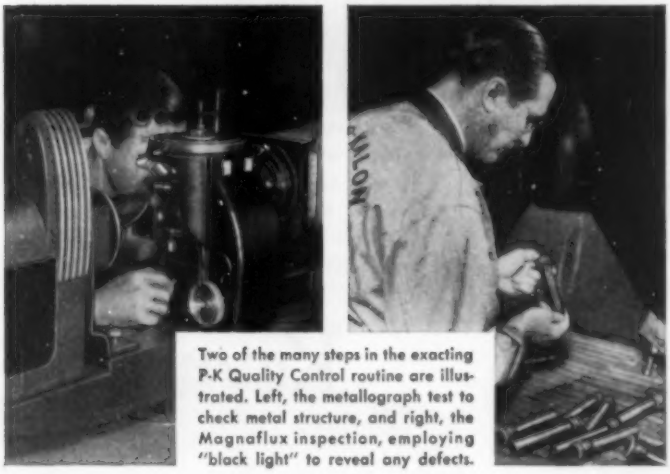
FOR ADVANCED DESIGN that speeds assemblies — makes them simpler, stronger — and saves errors.

FOR ASSEMBLY STRENGTH okayed in a million punishing tests by thousands of satisfied users.

FOR PLANNING AIDS and buying data patterned to your special needs, plus advice on assembly.

FOR SUPPLY SERVICE set up for fast action and lower purchasing expense — by local Distributors.

FOR ANY STYLE OR SIZE You'll find any Socket Screw you need in P-K's complete line. Hex Keys in all sizes, and several handy sets.



Two of the many steps in the exacting P-K Quality Control routine are illustrated. Left, the metallograph test to check metal structure, and right, the Magnaflux inspection, employing "black light" to reveal any defects.

PARKER-KALON SOCKET SCREWS

GET ALL THESE ESSENTIALS OF COST-WISE ASSEMBLY GET P-K

In Stock . . . see your nearby P-K Distributor . . . your local Supply and Service Specialist

weave... wire... mesh... metal...

to your specifications

Precision processed—from weave to wire, mesh to metal, ductility to durability—to your exact specifications—Reynolds Wire Cloth meets the special needs of your products. Details in *Sweet's Product Design File*... or consult Reynolds Engineers.

Reynolds WIRE CLOTH for Industry

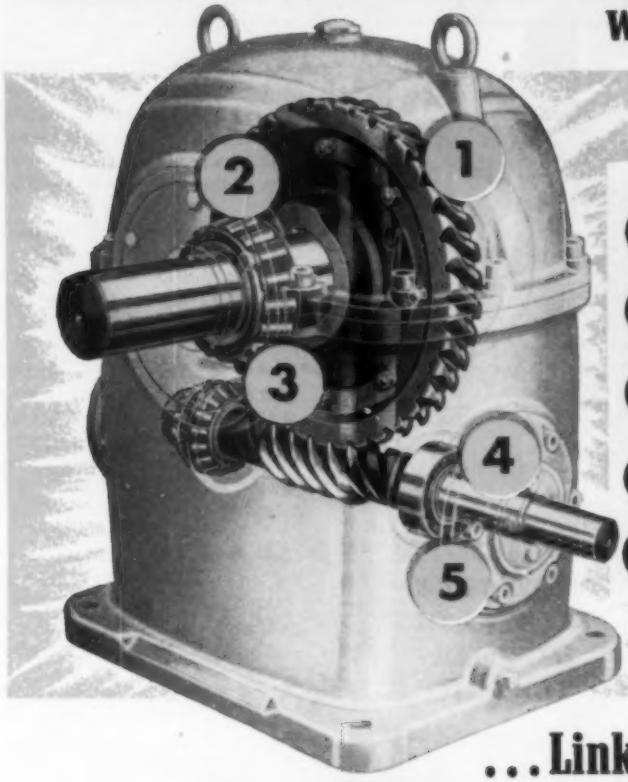
NS NATIONAL-STANDARD Company NILES, MICHIGAN

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes

When your speed reduction job calls for high ratios with right-angle takeoff...



1. **NICKEL-BRONZE WORM GEARS,** chill cast in dry sand, combine low coefficient of friction with high tensile strength.
2. **HIGH-CAPACITY ROLLER BEARINGS** take both thrust and radial loads. Lower wear and friction losses reduce maintenance.
3. **ALL-SPEED EFFICIENCY** results from reduced sliding action between worm threads and gear teeth, plus smoother power delivery.
4. **ONE-PIECE FORGED SHAFTS** are alloy steel, carburized and heat-treated for great impact resistance.
5. **AUTOMATIC SPLASH LUBRICATION** reliably supplies oil to all bearings and gear teeth at all speeds.

...Link-Belt gives you

everything you want in WORM GEAR DRIVES

WITH their compact, high-strength design, Link-Belt Worm Gear Drives permit high-ratio speed reductions in small space. High input speeds and low output speeds are provided, with ample capacity for heavy loads.

Three basic types cover the complete field of application: Single worm gear drives, helical worm gear drives and double worm gear drives. All are available with either horizontal or vertical shafts, and single or double gear reductions for convenient and compact connection.

Link-Belt Worm Gear Drives are available in 3.1:1 to 8000:1 reduction ratios, 1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324-A.

LINK-BELT 13,402

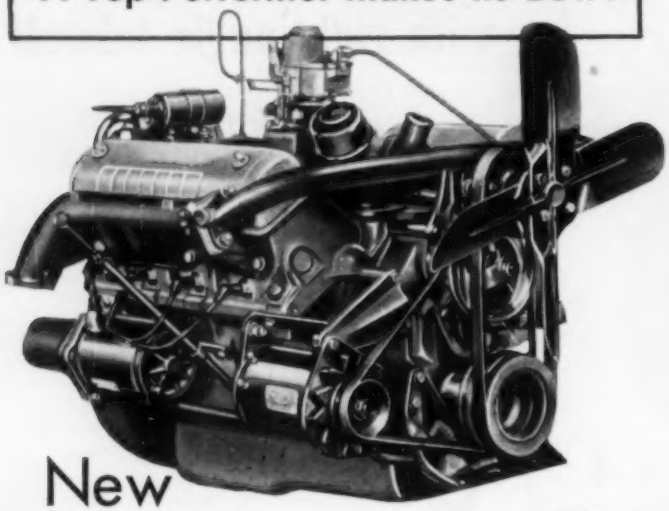
ENCLOSED GEAR DRIVES

WHY PRE-INTEGRATED LINK-BELT DRIVES CUT YOUR POWER TRANSMISSION COSTS

In addition to all three types of enclosed gear drives, Link-Belt builds variable speed drives, fluid drives—chains, sprockets, couplings, bearings, shafting, etc. All are pre-engineered for easy installation and maximum efficiency.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

A Top Performer makes its Bow!



New

FORD "239" CU. IN. V-TYPE, O. H. V. 8-CYLINDER INDUSTRIAL ENGINE

THESE MODERN-DESIGN FEATURES SPELL EXCEPTIONAL EFFICIENCY!

Providing More Economical Power for Countless Commercial needs

HERE'S IMPORTANT NEWS for manufacturers of powered equipment and for the actual operators of their products as well: Ford presents a brand new "239" Heavy Duty Industrial Engine of the latest Overhead-Valve Type, designed to out-perform, with gas-saving economy, other internal combustion power plants of comparable displacement on the market today.

Actual operating tests have demonstrated that this engine delivers *more* usable power on *less* gas, because Ford engineers have cut horsepower waste formerly lost to internal friction. And its many new modern design features contribute to more dependable operation and greatly increased life.

Structurally and mechanically, the Ford "239" incorporates the latest advancements in engine design. Take time right now to glance through a few of the many important details of this engine's design checked in column at right. And remember, we'll welcome your inquiry as to the application of this power plant to your equipment. Phone or write to:

INDUSTRIAL ENGINE DEPARTMENT
FORD MOTOR COMPANY
15050 Woodward Avenue, Highland Park 3, Michigan

A special 8-page folder fully describing this new Ford "239" Engine includes complete specifications, power curves, detailed dimensional drawings, available accessories, etc. Send for it today.

- **Gas Saving High-Compression**—High compression (7.2 to 1) delivers maximum power from every drop of regular gas.
- **New Short-Stroke Power**—Large bore and short piston stroke provide more usable power with less frictional losses, and slower piston speeds with less engine wear for longer life.
- **Overhead-Valve Design**—Design of valves and combustion chambers contribute to efficiency by more complete use of fuel.
- **Free-Turn Valves**—Free-turn intake and exhaust valves, with integral valve guides, cast as part of cylinder heads, are far superior to the usual valve guide inserts. Valve life is increased up to 50 per cent.
- **Full-Flow Oil Filter**—Cleans *all* the oil before it reaches bearing surfaces, reduces cylinder wall, piston ring and bearing wear; prolongs engine life.
- **Rigid Block and Crankshaft Design**—Provides greater rigidity to withstand the toughest kind of operation.
- **Precision-Built Throughout**—Using the best materials for every component part and the most advanced techniques of manufacturing, this engine is exceptionally durable to withstand hard, heavy-duty usage.

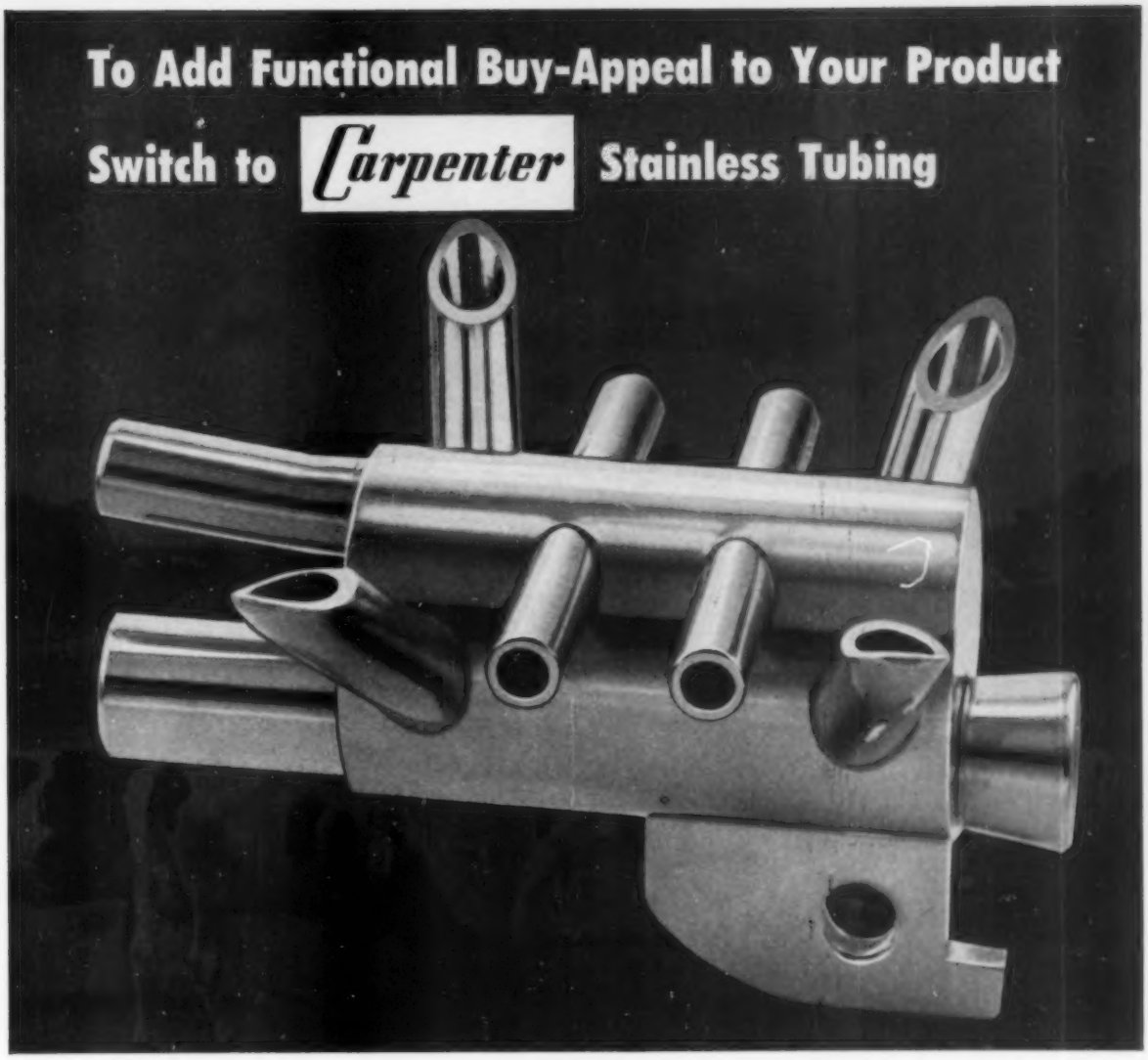
YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED!

Available as Closed Power Unit

Ford
INDUSTRIAL ENGINES AND POWER UNITS

To Add Functional Buy-Appeal to Your Product

Switch to Carpenter Stainless Tubing



Appearance is important to any product, of course. An example is the milking machine manifold shown above. But there are more reasons for specifying Carpenter Stainless than its shining beauty.

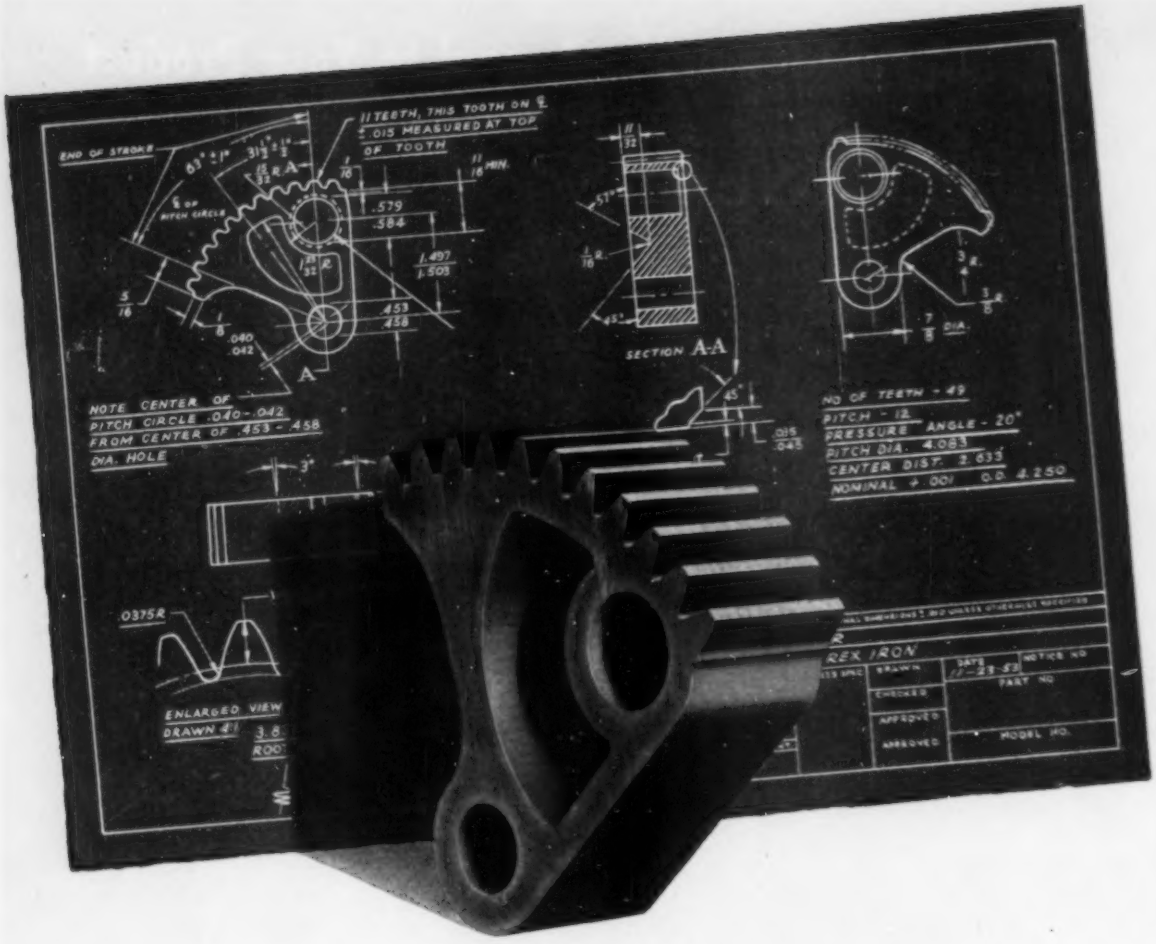
Long-life and corrosion resistance, for example—excellent strength for weight ratio, workability, ease of machining, brazing and welding. And when you call for Carpenter you get some important "extras". *Uniformity* of dimension, analysis, concentricity from length to length and order to order is one of them. Another is Carpenter's *availability*. Adequate distributor stocks in key areas coast to coast, plus Carpenter's "cross stock availability plan" insures delivery of the tubing or pipe you need, when and where you need it.

For more complete information on Carpenter Stainless Tubing and Pipe, write today for the new Condensed Data File. It contains data on physicals, analyses, dimensions, weights, tolerances and fabrication.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.
Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe



COMPLEX PARTS ARE A CINCH FOR MORAINE POWDER METALLURGY

By conventional casting and machining methods, this part would be high in cost and would require extensive equipment investment. Through the use of metal powder techniques, it has been mass-produced with important over-all savings.

Note the construction details on the print in the background. Formerly many machining processes were necessary before this part was ready to be assembled into a complete, operating mechanism. Now it comes from a press complete in a single operation . . . another example of what can be accomplished through cooperative effort between customer and Moraine.

Moraine's experience with metal powder is contributing widely to modern industry. Many complex designs are resolved into practical, economical production jobs that improve performance and lower costs.

m

moraine products

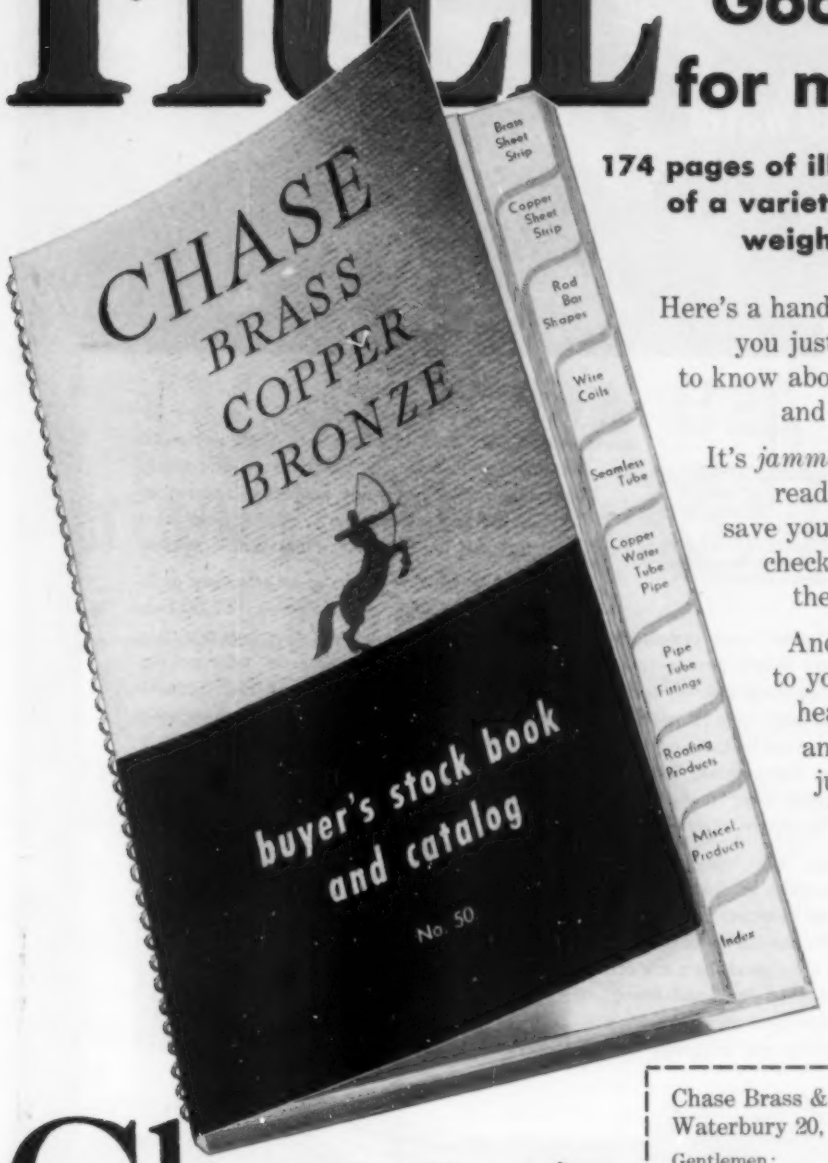
DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

METAL POWDER PARTS

FREE

Good reading for metal men!

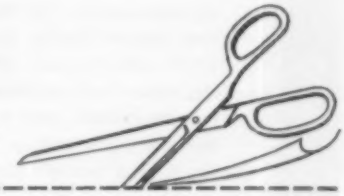
174 pages of illustrations and listings of a variety of products...sizes... weights...tempers...shapes!



Here's a handy, desk-size book that gives you just about *everything* you need to know about brass, copper and bronze and now . . . stainless steel, too!

It's *jammed to the brim* with easy-to-read data. It's *thumb-indexed* to save you time. It has a how-to-order check list that's designed to take the headaches out of ordering.

And what's more, it comes *free* to you from Chase—the nation's headquarters for copper, brass and bronze. To get *your* copy, just clip and mail the coupon below.



Chase Brass & Copper Co.
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Please send me your Buyer's Stock Book and Catalog.

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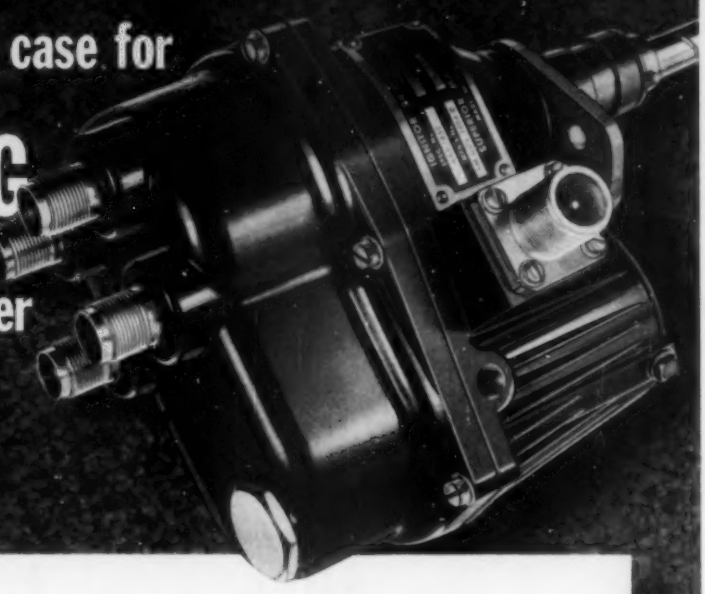
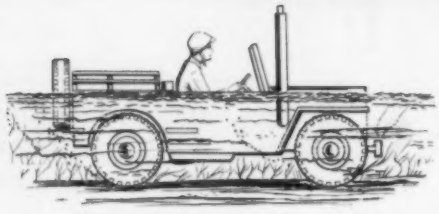
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)

Here's a watertight case for DIE CASTING ...in this underwater ignition housing



CASE HISTORIES FROM MT. VERNON FILES

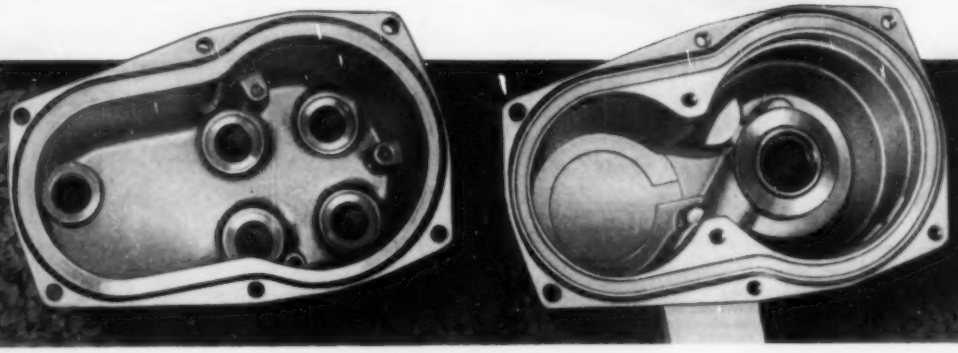


This is a waterproof "Ignitor"—a distributor and ignition coil combined in one case—for a motor vehicle which must operate at times under water. Searching for the *best* way to produce the intricate housing which must keep its contents bone-dry under pressure, the makers, Superior Magneto Corp., Long Island City, N. Y., chose a 2-piece case die cast in aluminum by Mt. Vernon.

Says Superior Magneto: "With die casting we get light weight, with thin walls of great strength and uniform density, able to stand a 300-hour 2½ G. vibration test. With a minimum of machining, dimensional stability is so good the parts are interchangeable, with no need for hand fitting. Both the brass bushings for spark-plug wires and the steel drive-shaft bushing are integrally cast—and they're tight enough to keep out water under pressure. Finally, the finish of the castings is so good, we apply the protective coating directly, without sand blasting or cleaning. All these add up to a fine product, economically made."

Whatever your product, whether simple or intricate, consult with us. We have 162,000 sq. ft. of facilities for die casting aluminum and zinc, and a vast reservoir of experience in die making. Perhaps we can help you, as we helped Superior Magneto, to lower unit costs . . . show you the way to improved products, too.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



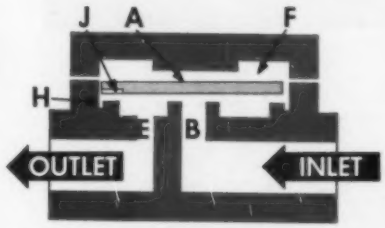
SARCO
Thermodynamic
STEAM TRAP

ACTUAL SIZE

this new trap virtually eliminates maintenance

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation and leakage thru slot J, pressure in tube B raises disc and cycle is repeated.

The Sarco *Thermodynamic* Trap is ideal for rugged, heavy-duty service; for pressures to 600 psi and temperatures to 950° F. Has proved successful on alternate heating and cooling equipment, engine and turbine stop valves; steam separators, and similar applications.

A solid stainless steel disc—practically indestructible—is the only moving part!

Most striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part – a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air – snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for free trial. All you do is fill out the coupon and mail it in.

SARCO COMPANY, Inc.
Empire State Building, New York 1, N.Y.

MAIL COUPON TODAY FOR FREE TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for free trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

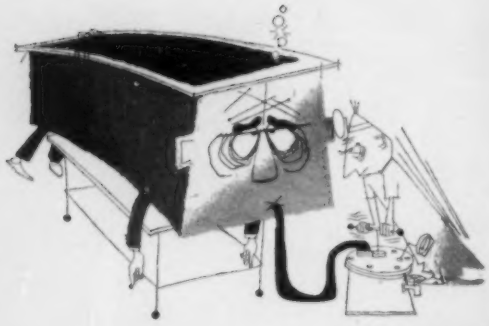
For installation on.....

NAME_____

FIRM_____

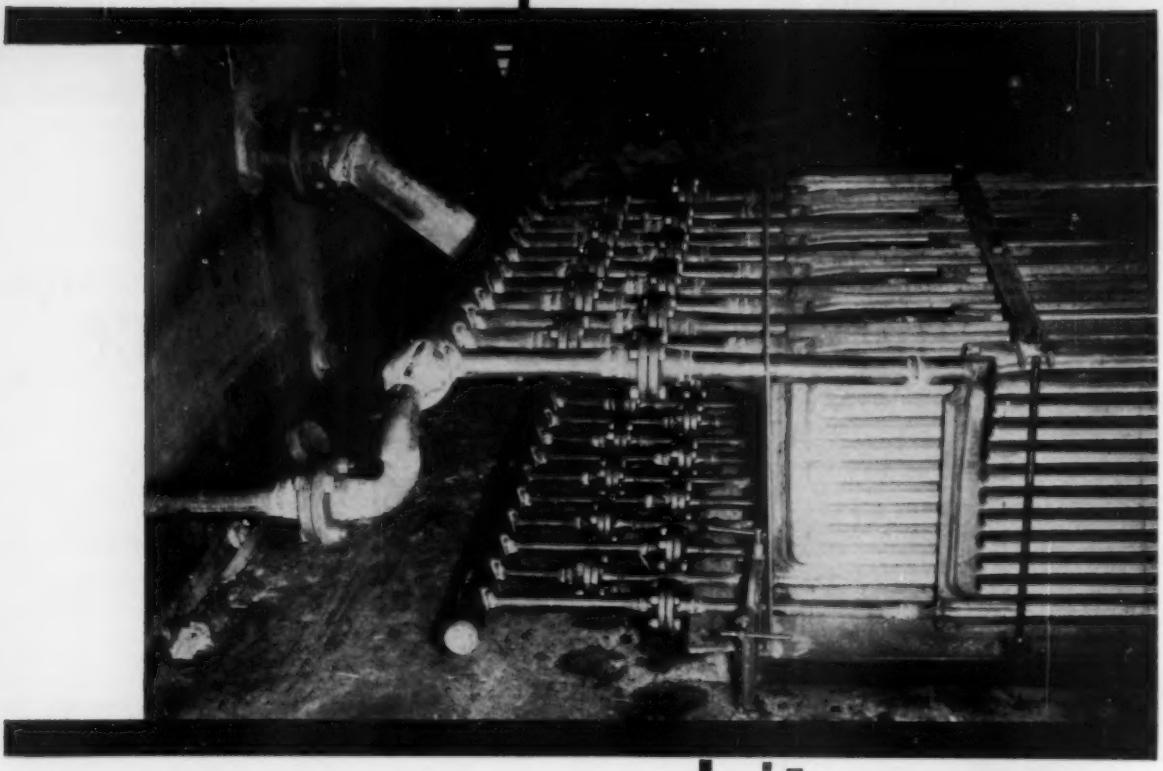
ADDRESS_____

CITY_____ STATE_____



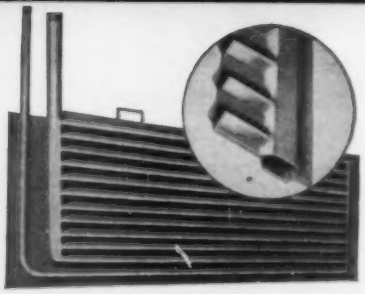
steam costs cut 96%
as PLATECOILS
cure coil-itis *

Old Colony Tar Company cut their steam costs 96% and saved a full week heat-up time per removal by replacing pipe coils with Platecoils in their tar storage tanks. It took a week for the pipe coils to heat a 250,000 gallon tank to pumping temperature . . . now, with the Platecoils, there is no heat-up time required. It cost $100.00 per removal for steam . . . now steam costs have been cut to $4.00 per removal, and $96.00 is saved. This installation is described in detail in Bulletin P77 shown below.

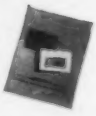


PLATECOILS *replace pipe coils for 50% of the cost*

* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.



Bulletin P77 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.



Platecoil Division, TRANTER MANUFACTURING, Inc., Lansing 4, Michigan

For fast shipment see your local distributor

New Taylor laminates

are premium in everything but price

YOU'LL LIKE everything about this new family of Taylor paper-base laminates—including their price. They're a new kind of hot-punch laminate, uniform all the way through, with no surface overlay of resin.

In insulation resistance, water absorption, power factor, flame retardance and dimensional stability, they'll meet or exceed your strictest specifications. And they punch and stake so well . . . with smooth surfaces and clean edges . . . that you can produce complex parts with maximum utilization of each sheet.

Four different grades are available in production quantities, in standard sheet size of approximately 49″ by 49″:

XXXP-301 . . . *the top grade laminate* with unusually high insulation resistance, lowest water absorption . . . excellent punching and staking.

XXP-351 . . . a high grade laminate with most of the properties of XXXP-301, at lower price.

Grade 353 . . . a quality grade laminate priced for economy, with outstanding electrical and physical properties.

Grade 354 . . . an easily fabricated grade having low water absorption and good stability . . . priced for real savings.

Taylor Fibre Co. Plants in Norristown, Pa.; and La Verne, Calif. *Branch offices in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

WRITE TODAY FOR FULL SPECIFICATIONS, AND FOR ENGINEERING ASSISTANCE IN APPLICATION

TAYLOR
Laminated Plastics
Vulcanized Fibre

Seeing is Understanding

You'll see how the elimination of flanges and undercuts on the inner ring provides a *wider* contact area for the rollers.

This SKF Story Of Spherical Bearing Design Improvement

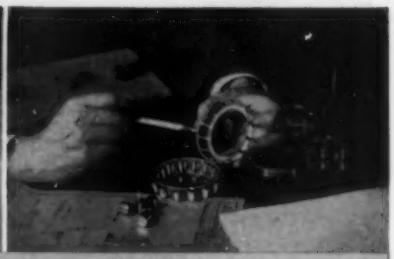
When SKF first announced that its *improved* (Type "C") Spherical Roller Bearing provides, size for size, up to 50% more capacity and 2 to 3½ times longer life than any other available design, most people asked:

"How was this done?"

Your SKF District Office has the answer, in the form of a clear, quick *visual* demonstration. Ask to see it—here, in outline, is what you'll see!

You'll see how much longer the Type "C" Rollers are than those in the original SKF design.

You'll see the way the rollers are *guided* by a separate floating guide ring, free to move axially.



You'll see the improved brass *window-type* cage—see why it's stronger and more effective.

You can see an exact comparison of original vs. Type "C" capacity and life in the sizes of sphericals you use.

SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC.
PHILADELPHIA 32, PA.

YES—We'd like to have an SKF Representative SHOW us WHY the improved SKF Type "C" Spherical provides, size for size, more capacity and longer life than any available spherical design.

Name .....

Company .....

Address ..... *State* .....

Mail this coupon NOW and SEE why you can get better spherical roller bearing performance. No obligation, of course.

SKF INDUSTRIES, INC., PHILA. 32, PA.—*manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

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DU PONT
REG. U.S. PAT. OFF.

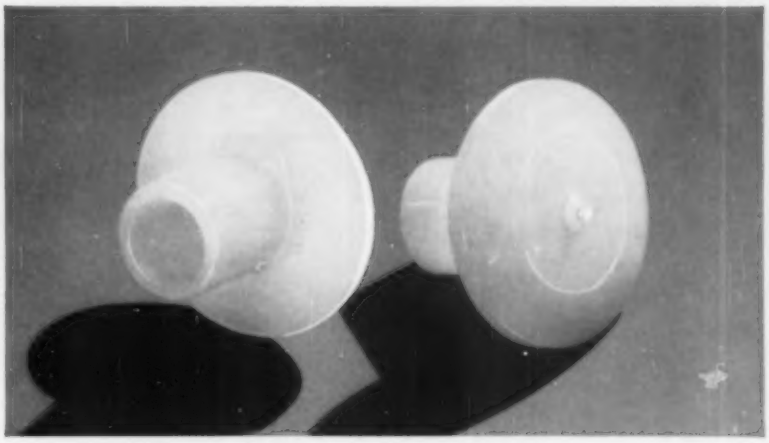
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

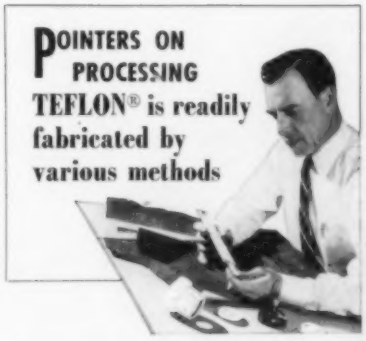
NO. 4 — 1954

Valve Poppets of Du Pont "Zytel"* Solve Problem of Inertia in Low-Pressure Gas Compressor Valve

In 2-year test, poppets of Du Pont "Zytel" nylon resin withstand impact of 300,000,000 open-and-close cycles without failure.



Valve poppets for gas compressors manufactured by Thompson Products, Inc., Bell, California, are injection-molded of "Zytel" nylon resin by Reinhold-Geiger Plastics, Inc., Los Angeles, California.



SEVERAL techniques have been developed for rapid fabrication of Du Pont "Teflon" into various shapes.†

One new extrusion method permits mass production of parts with section thicknesses as low as 5 mils or as high as ¼ of an inch. This process is ideal for producing tape, tubing, and wire insulation. And it can readily be adapted to the manufacture of monofilament and irregular shapes.

The new process is a simple one, requiring only four easy steps:

(1) A composition of Du Pont "Teflon" is preformed by compression, then placed in a ram-type extruder. (The composition consists of a fine powder of "Teflon" mixed with volatile extrusion aids and, if desired, pigments for coloring.)

(2) The composition is ram-squeezed through a die to produce the desired shape.

(3) The extrusion aids are removed from the shaped part by volatilization.

(4) The part is then sintered and quenched.

Laboratory tests show that, by the above method, ½"-diameter tubing of "Teflon" can be extruded at 10 feet per minute. Production speed increases as the tubing diameter decreases. Also, a 15-mil insulation has been extruded on Number 16 AWG copper wire at 12 feet per minute.

Even with such production speeds, shapes of "Teflon" made by the above process have the excellent physical and

(*Continued on Page 2*)

†Conventional molding and extruding techniques for plastics are not applicable to "Teflon", because it does not melt and flow. Nor can it be dissolved.

Gaskets and packing of Du Pont "Teflon" assure long service life in "trouble spots"

HAVE you evaluated Du Pont "Teflon" for use as gasket and packing material?

In many applications, the performance of "Teflon" tetrafluoroethylene resin has been truly spectacular. It is inert to every chemical and solvent encountered in industry, with these exceptions: molten alkali metals, and fluorine at high temperatures and pressures.

Gaskets and packing of "Teflon" have zero water absorption (by ASTM test D 570-42) and are not affected by outdoor weathering. They give satisfactory service at temperatures ranging from −450°F. to 500°F.

For more information about Du Pont "Teflon" and its application for packing and gaskets, mail the coupon on the reverse side of this page.

THOMPSON PRODUCTS, INC., of Bell, California, reports superior performance of valve poppets molded of "Zytel" nylon resin in compressors which handle air, ammonia, butane, propane, and natural gas. These poppets are used where the pressure is less than 1,000 psi and the temperature below 280°F.

In this low-pressure range, the weight of poppets formerly used set up inertia forces which impaired valve efficiency. To overcome this, engineers at Thompson Products installed a test set of poppets molded of "Zytel" nylon resin in a natural gas compressor operating at 300 rpm with 840 psi discharge pressure. *After 2 years of continuous operation involving 300,000,000 open-and-close cycles, the poppets of "Zytel" showed no sign of wear.*

Because of its strength, combined with lightness of weight, Du Pont "Zytel" nylon resin (1) solves the inertia problem, (2) reduces valve-opening shock load which lengthens coil spring life, (3) lessens pounding force on

*"Zytel" is the new trade-mark for Du Pont nylon resin.

OVER

DU PONT
REG U S PAT OFF

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1954

Valve Poppets of "Zytel"

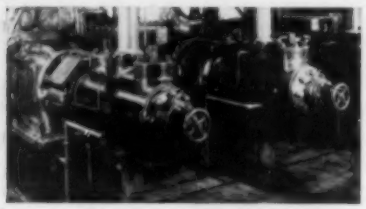
(*Continued from Page 1*)

the valve body seat and other poppet-enclosure areas, and provides quieter operation than did poppets formerly used.

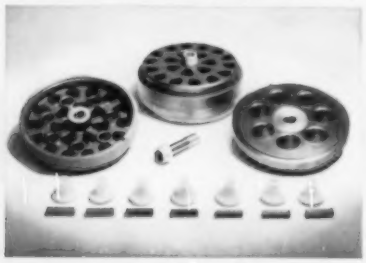
Du Pont "Zytel" nylon resin is used without danger of corrosion in the presence of ammonia, butane, and similar gases.

These valve poppets of "Zytel" are economically made by injection molding. By this method parts can be made quickly, to close tolerance, and generally require no finishing operation.

Investigate the unique properties which Du Pont "Zytel" has to offer. Write for more information, or clip the coupon.



Gas compressor valves made by Thompson Products use valve poppets of Du Pont "Zytel" nylon resin to reduce inertia, increase efficiency.



Component parts of valve show poppets of "Zytel." One to 36 poppets are used per valve. Poppets of Du Pont "Zytel" are chemically inert to butane, propane, ammonia, other gases.

"Teflon" is readily fabricated by various methods

(*Continued from Page 1*)

dielectric strength characteristics for which "Teflon" is noted and which no other material can match.

There are alternate methods of fabricating "Teflon": molding, coining, hobbing, and screw-extruding, for example. "Teflon" can also be machined with ease, to tolerances of ±.001 inch.

Write today for further detailed information about these manufacturing techniques. Just fill out and mail the coupon at the botton of the page.

Investigate Du Pont engineering materials in your product development programs

ONE OF the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

New flashlight of Du Pont "Alathon" is virtually unbreakable

HERE'S a new twist in product design. It's a flashlight with battery section, end cap, and lens retaining ring all molded of Du Pont "Alathon" polyethylene resin. Results: lighter weight, long service life, resistance to water and corrosion, and excellent dielectric properties, which permit design and assembly simplification.

Three flashlight parts molded of Du Pont "Alathon" by Gits Molding Corporation, Chicago, Illinois. The manufacturer guarantees it unbreakable in normal use.

Breakage Virtually Eliminated

Du Pont "Alathon" combines lightness with strength and resiliency. If the flashlight is dropped accidentally, there is no danger that the screw connection or case will be permanently bent and made useless. "Alathon" cushions blows so well that it helps protect the bulb filament from damage by rough handling.

The flashlight manufacturer, Gits Molding Corporation, Chicago, Ill., has thoroughly tested the case molded of "Alathon," and guarantees it unbreakable if not wilfully abused.

"Alathon" Is Durable

"Alathon" offers other advantages, too. It resists corrosion and chemical attack, protecting the flashlight from oil, gasoline, or other solvents. What's more, the parts of "Alathon" form a water-resistant seal. Du Pont "Alathon" polyethylene resin has excellent dielectric properties. Contact points leading to the flashlight switch do not require additional insulation, as "Alathon" is itself an insulating material.

Write today for further information about Du Pont "Alathon" polyethylene resin, or use the convenient coupon.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 107, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite." I am interested in evaluating these materials for* _____

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

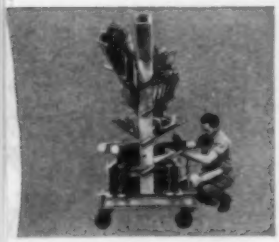
*"Alathon," "Lucite," "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.

Magnesium extruded shapes ready for immediate shipment.

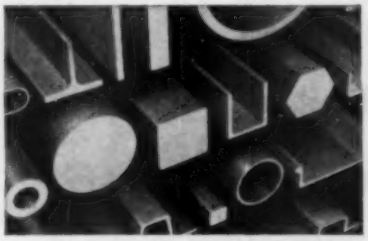
a new look at Magnesium!

NEW AVAILABILITY... SHAPES AND LENGTHS NEVER BEFORE EXTRUDED

Designers and cost-conscious production men have found the answer to their problems in many applications with magnesium extrusions—now produced by new Dow facilities. Standard and special shapes, bars, rods and tubing—all are readily available in alloys which save weight, add strength, cut costs. Get information on magnesium from your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan.



Inspector checking special extruded shapes offered in a wide variety of alloys and sizes.



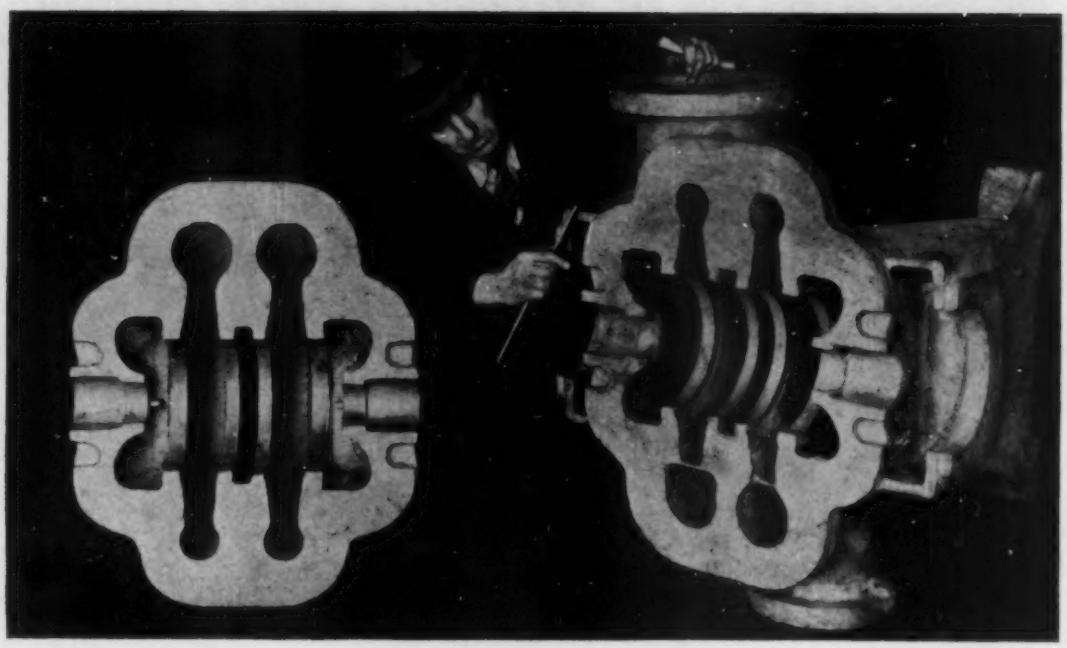
Magnesium bars, rods, shapes and tubing. Available in diameters or cross sections up to 10 inches.

World's first 84-inch magnesium coil mill now rolls sheet and plate in greater lengths and widths.

This coil of magnesium sheet started through the 84-inch coil mill as a one-ton rolling ingot.

you can depend on DOW MAGNESIUM

DOW



There's NO problem in Stainless Castings that we can't answer for you—

Write for your copy: "ALLEGHENY METAL CASTINGS"

32 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

ADDRESS DEPT. PE-55

Odd shapes or intricate sections are certainly no problem—look at some of our Allegheny Metal casting products illustrated above. We could show you hundreds more. And size is no consideration, either—we're equipped to handle any stainless castings—from a few ounces to thousands of pounds.

The really important point for you to consider is not the matter of shape or size, but of *experience.* The AL Buffalo Foundry is a group of specialists in high-alloy steel castings *exclusively* . . . pioneers in both the static and vertical-centrifugal methods of casting stainless steels.

For your assurance, there's a long record of years of successfully answering difficult service conditions with sound, clean-grained Allegheny Metal castings—free from defects, easy to machine and dependable in supply. ● Let us quote on *your* stainless casting requirements. *Allegheny Ludlum Steel Corporation, Henry W. Oliver Building, Pittsburgh 22, Pennsylvania.*

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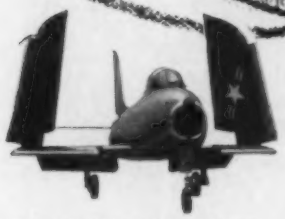
AL® TIME-TESTED STAINLESS STEEL

WAD 5008 **Warehouse stocks carried by all Ryerson Steel plants**

HELL HATH NO FURY

LIKE NAVY'S NEW FJ2 FURY FIGHTER



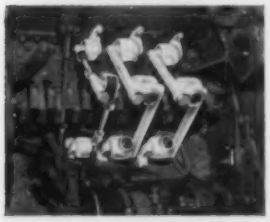
Chiksan swivel joints and assemblies permit the wings to be folded for aircraft carrier storage.

Chiksan Aero-Hydraulic Swivel Joints Chosen by North American

Chiksan aero-hydraulic swivel joints and assemblies convey hydraulic power through the complicated folding wing area of this sleek navy fighter. Flexible as rubber with the strength of steel, these swivel joints flex in a predetermined arc, avoiding the possibility of entangling lines.

By eliminating the tubing and providing a single forged unit in this 3000 psi system, Chiksan saves in space and assembly time with the added assurance of absolute safety in control performance by removing eight possible points of leakage.

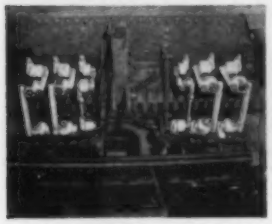
For these reasons, North American, world's largest builder of military aircraft, has joined the roster of famous air-frame manufacturers employing Chiksan swivel joints and assemblies.



When wings are in the horizontal position, the joints form solid lines carrying hydraulic fluids.

Representatives in Principal Cities

Write Dept. 7-PE For Complete Chiksan Catalog



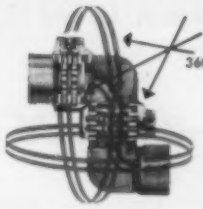
Chiksan assemblies provide a fixed arc of travel, allowing a compact grouping of duplicate sets of lines.

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

THE NEW TOOL OF MODERN INDUSTRY



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

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Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif., Newark 2, N.J. • Chiksan of Canada Ltd., Edmonton, Alta.

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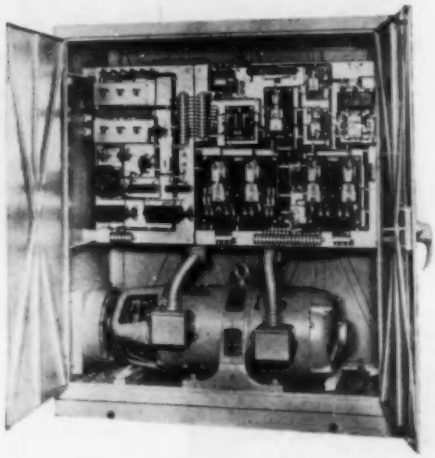
with a Performance Rated® Century SELECTIVE SPEED DRIVE

- **Offers automatic control integrated with your process.**
- **Covers a wide speed range—forward or reverse.**
- **Starts, stops—fast or slow.**
- **Allows forward or reverse jogs.**
- **Controls one or more motors.**

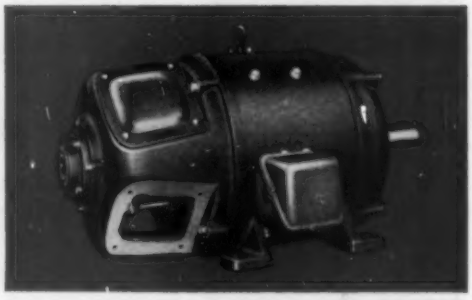
With a Century Performance Rated Selective Speed Drive, you can often integrate speed changes to cycle automatically as the process requirements dictate.

- You can automatically regulate metal cutting for optimum cutting speeds.
- Make the speed change automatically sensitive to changing temperature or pressure.
- Make the speed change automatically sensitive to changing diameter of a feed roll.
- Make the speed change automatically sensitive to the viscosity of a mix.
- You can use many different kinds of control devices in the control circuit to change speeds ... to jog ... to apply dynamic braking, etc.



You're welcome to full information on your specific drive problem. Call your nearest Century District Sales Office or Century Authorized Distributor, or write direct. See telephone listings.

Century makes A. C. and D. C. motors 1/8 to 400 H. P.



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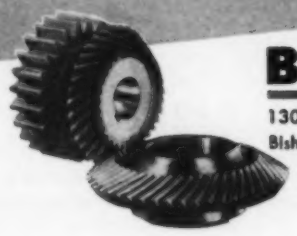

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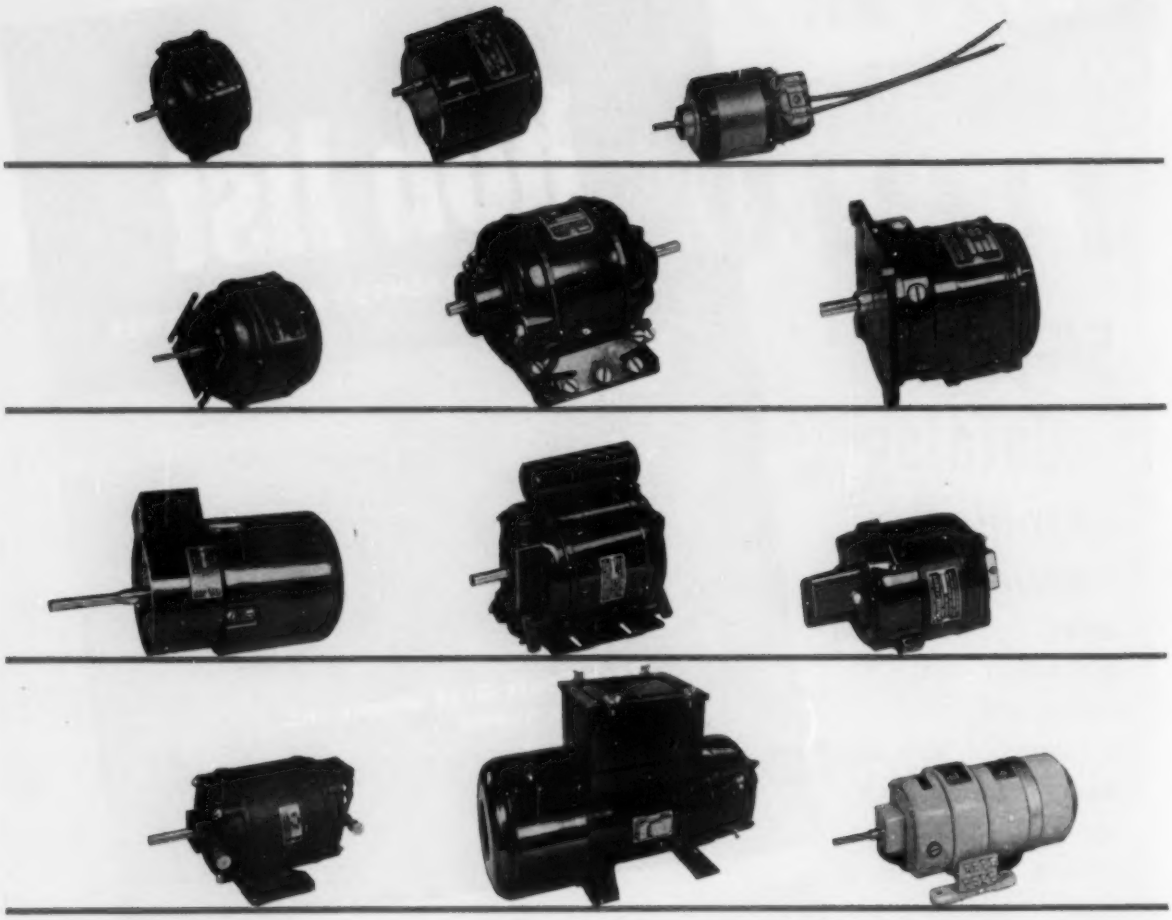

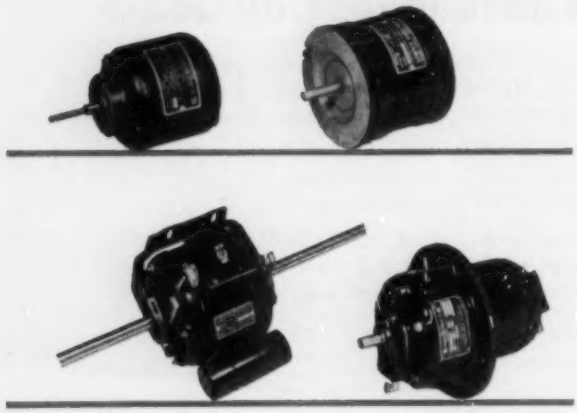

each of these HOLTZER-CABOT motors solved a special problem!

Holtzer-Cabot specializes in motor and generator design, and is tooled to produce both AC and DC motors at lowest possible cost, in a wide range of frames, with unlimited varieties of mechanical and electrical features.

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Bring your small-motor application problem to Holtzer-Cabot. Our experience in developing custom-built motors assures you of a prompt and expert solution.

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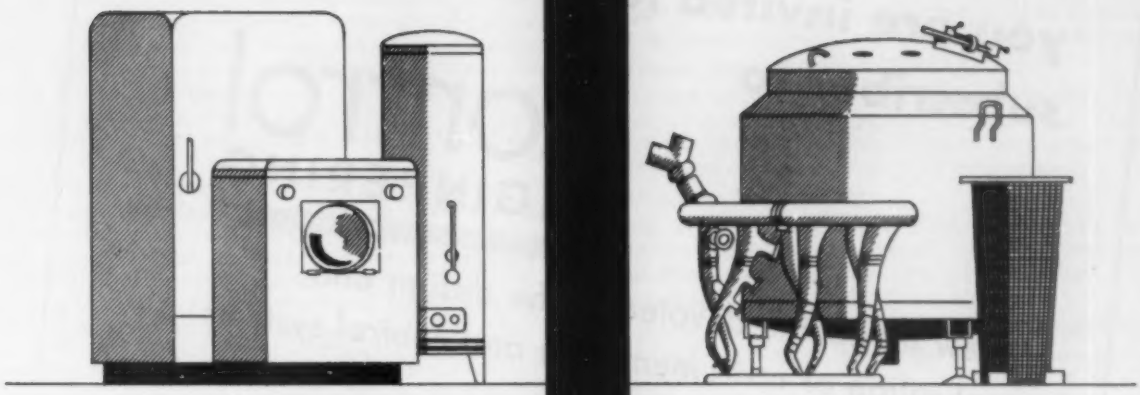

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To assist engineers and designers in properly appraising the advantages of Porcelain Enamel, we will be glad to furnish technical data and assistance.

The Porcelain Enamel DESIGN MANUAL shown here gives practical suggestions and factual data helpful in making most effective use of this modern engineering material. We will be glad to send you a copy.

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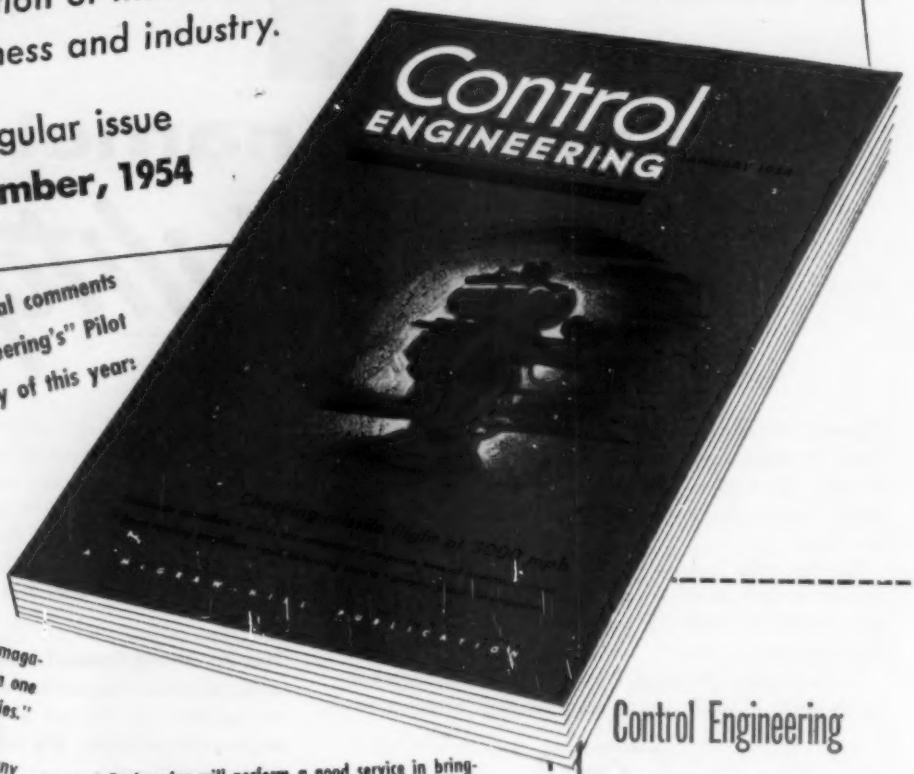
INSTRUMENTATION AND AUTOMATIC CONTROL SYSTEMS

a new magazine devoted to the design and application of instrumentation and control systems in business and industry.

first regular issue
September, 1954



Here are some of the typical comments received on "Control Engineering's" Pilot Issue published in January of this year:

"You have produced an excellent magazine that should be well received in one of America's fastest growing industries."
Instruments Engineer
Textile Manufacturing Company

"Control Engineering will perform a good service in bringing all the instrument advertising together under one cover."
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"Control Engineering will be useful to those who make and use instrumentation."
Production Manager
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"Control Engineering fills a need and we would most certainly be a subscriber."
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Control Engineering
330 West 42nd Street
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Conceived Over 10 Years Ago by McGraw-Hill Editors

Research in the science of feed-back systems during World War II brought a new dimension to the art of instrumentation and control for business and industrial processes and machinery.

Out of this development a new engineering art—the design and application of closed-loop control systems—has grown. It can provide a new level of productivity for American business and industry.

Since 1944, McGraw-Hill has been conducting a series of market analyses to determine editorial scope, circulation and advertising potentials for a magazine serving this field. The most recent of these studies, conducted early in 1953, indicated a strong current need for such a magazine among design engineers and technically trained management men in a broad range of industries.

Accordingly, in January, 1954, the first pilot issue of CONTROL ENGINEERING was published. Field surveys indicated an enthusiastic reception on the part of the men it was designed to serve. Many letters were also received praising its editorial scope and usefulness. Strong advertising support was voiced by leading manufacturers of instruments and control devices.

How CONTROL ENGINEERING Will Serve You

1. Every issue of CONTROL ENGINEERING will show you how instrumentation and automatic controls are being applied in your own and related industries. It will describe new methods as they are developed. It will describe them in terms you can use.

2. CONTROL ENGINEERING will serve as a shop and laboratory manual filled with down-to-earth, practical data. It will aid you as a management man interested in increased production, improved quality and lower costs. It will aid you as an engineer interested in the methods and equipment required to attain these goals.

An Editorial Staff of Recognized Ability Will Bring You Current Facts And Information On Instrumentation and Automatic Control

CONTROL ENGINEERING's Editorial Staff provides a unique pool of background expertness in all phases of modern control technology. At its command are the resources of McGraw-Hill's national and international business-news-gathering facilities and technical services.

System-Engineering

Associate Editor William E. Vannah, a specialist in the function of instrumentation in plant dynamics and contemporary instrument and system design, was associated for the past five years with the Research and Development Division of Foxboro Instrument Company.

Mathematician-Editor

George A. W. Boehm, formerly science editor of Newsweek, a mathematician and specialist in interpreting current technical developments, has been appointed Managing Editor of CONTROL ENGINEERING.

Servo-Technology

Associate Editor Byron K. Ledgerwood, formerly an editor of Product Engineering, specialized in reporting on servomechanisms in machine and system design.

Process Control

Business Editor Lloyd E. Slater, former Industry Manager at Minneapolis-Honeywell and Associate Editor of Food Engineering, specialized in development and application of automatic controls in processing.

Computer-Engineering

Assistant Editor Edward J. Kompass, formerly with The de Florez Company, Inc., is skilled in the design and development of digital computer technology.

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Supplementing its working Staff, CONTROL ENGINEERING will draw upon the advice and experience of a Board of Consulting Editors comprised of four outstanding authorities in the field.

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- –Automatic Gaging and Weighing Controls
- –Automatic Selection and Transfer Methods
- –Electrical, Electronic and Mechanical Controls
- –Indexing and Recording Equipment
- –Instrumentation Inspection Equipment
- –Magnetic Tape Operating and Inspection Methods
- –Punch Card Operating Equipment
- –Servo Systems . . . and many more

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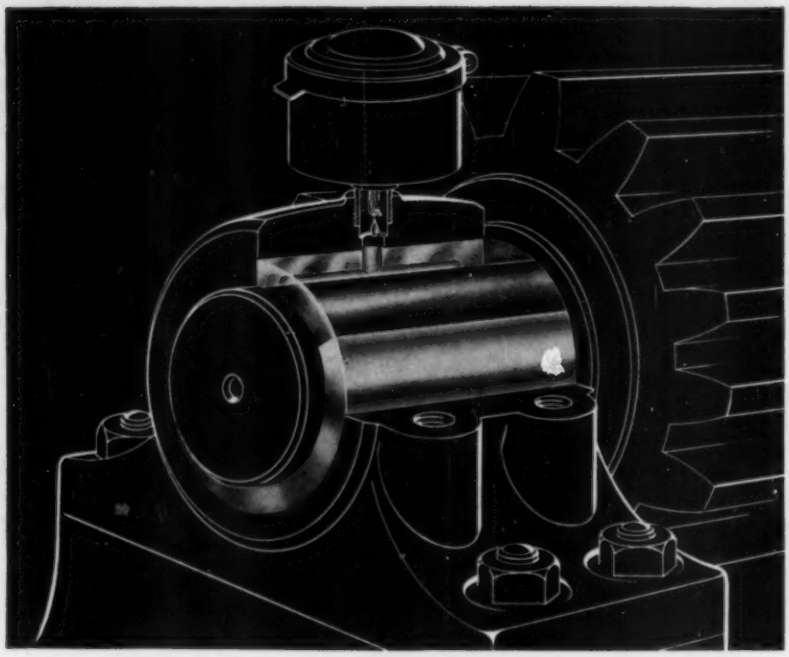
THE WAY TO CUT...

Cost of added parts



Give careful thought to the added parts required for the satisfactory functioning of some bearing types and not necessary with the simple uncomplicated sleeve bearing. Lock nuts and lock washers needed to fasten some bearing types to the shaft are absent in sleeve bearing design. With the sleeve bearing there is nothing to lock to the shaft. Intricate end covers required for locating or enclosing some types of bearings again are absent in sleeve bearing design. Where the sleeve bearing is to be of the floating type it is simply inserted by hand in the part in which it is to operate. The bearing is delivered to you ready for installation with the actual easy assembly in housing and on shaft all that is left to do. Where the sleeve bearing is to be of the pressed-in type it is simply pressed into the gear, gear box, lever or housing in which it is to function.

There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.

Bunting®

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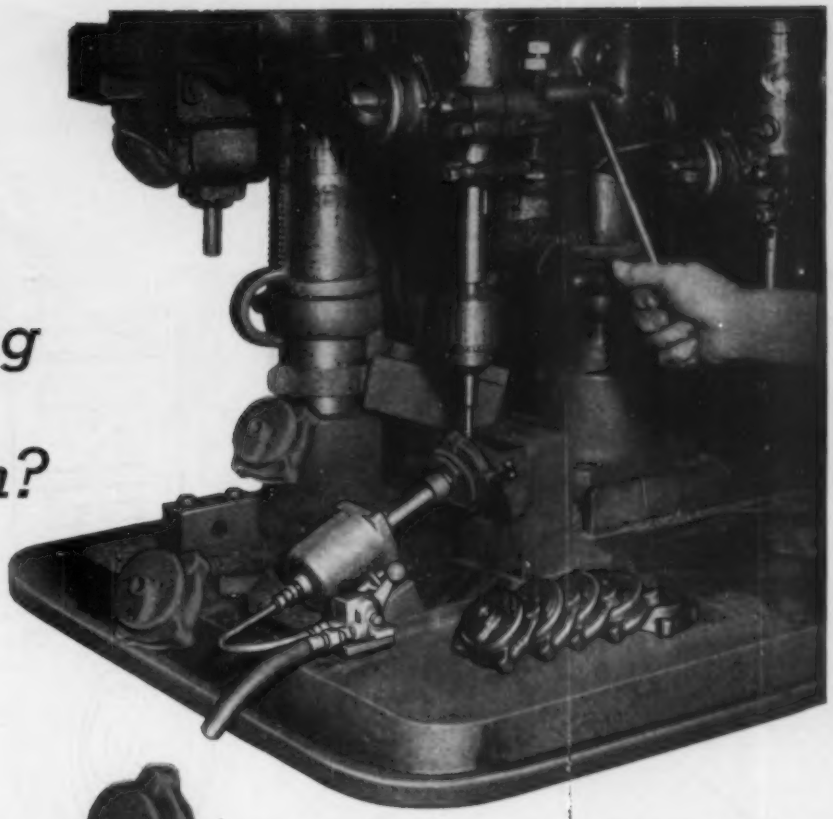
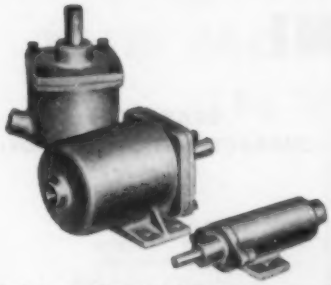
Clamping Problem?



SCHRADER has the answer!



Schrader Air Clamping Cylinders are available either base or leg mounted, in 1", 2½" and 3" diameters delivering a 2" or 1" stroke. A wide selection of Schrader Valves is available to operate this equipment.

Schrader

REG. U. S. PAT. OFF.

Leaders in air control since 1844

The **Schrader Air Clamping Cylinder** is actually a bantam air cylinder that can *add several minutes* to each worker's production hour . . . eliminate the need for slow, manual clamps.

Think of all the clamping operations in your own shop. Milling machines . . . drill presses . . . power presses . . . welders . . . gluers – and many dozens of other machines that are now idling for ten or fifteen seconds while operators go through slow clamping operations. Why not save time – and operator annoyance – with fast, convenient Schrader Clamping Cylinders, as so many other industrial plants have already done? Remember, you can mount these Schrader Clamping Cylinders anywhere – and actuate them automatically or manually.

For full details on the models available – or any of the hundreds of air control products in the complete Schrader Line – write today. Or, if you prefer, fill out the coupon below.

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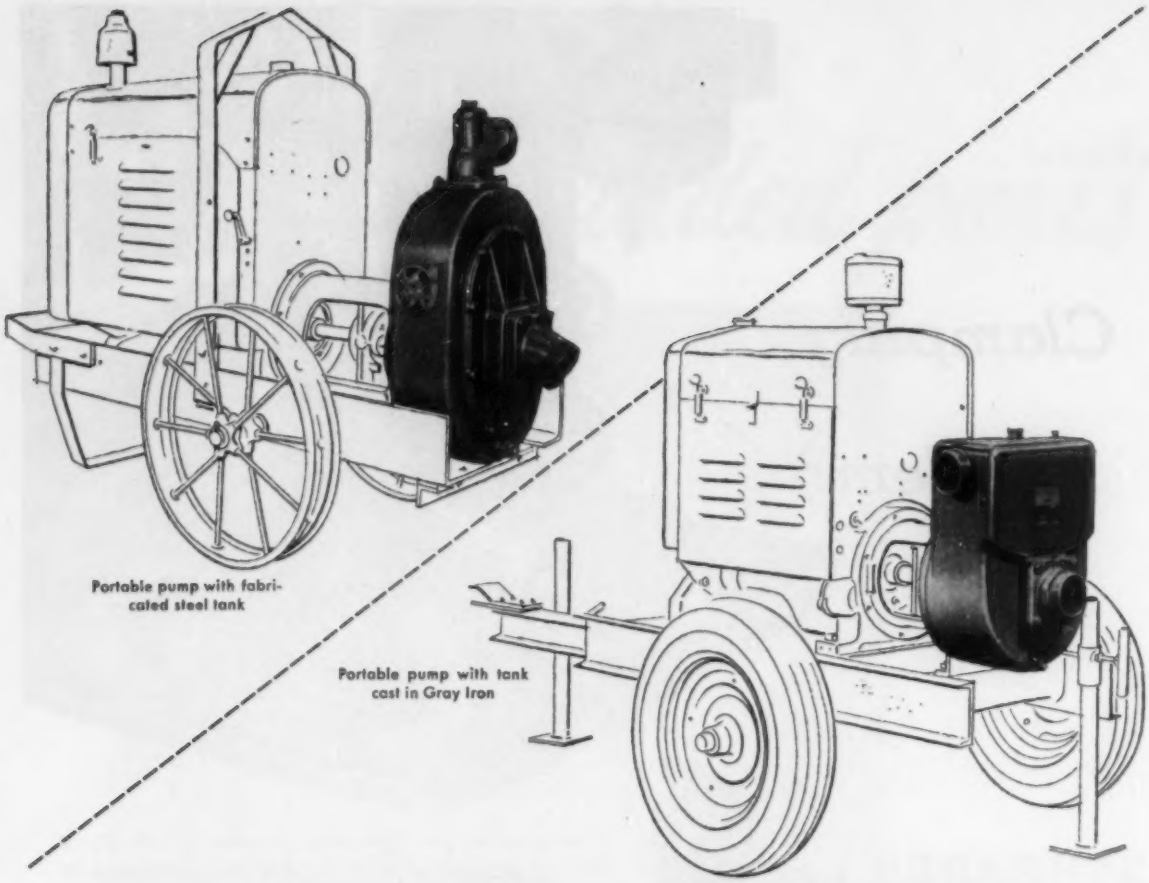
Company_____

Address_____



Portable pump with fabricated steel tank

Portable pump with tank cast in Gray Iron

Costs down 20%... efficiency up with GRAY IRON!

This Marlow portable self-priming centrifugal pump originally was made with a fabricated steel pump tank. In modernizing the unit the manufacturer redesigned the tank for production in Gray Iron, thus realizing a *20% saving in costs* . . . as well as substantially increased efficiency over the fabricated tank previously used.

This same type of cost-saving story may be told about some of your fabricated parts, if you take the time to consider the many advantages of the Gray Iron casting process. Write for technical information.

GRAY IRON CHARACTERISTICS INCLUDE:

CASTABILITY
STRENGTH
RIGIDITY
LOW NOTCH SENSITIVITY
WEAR RESISTANCE
HEAT RESISTANCE
CORROSION RESISTANCE
DURABILITY
VIBRATION ABSORPTION
MACHINABILITY

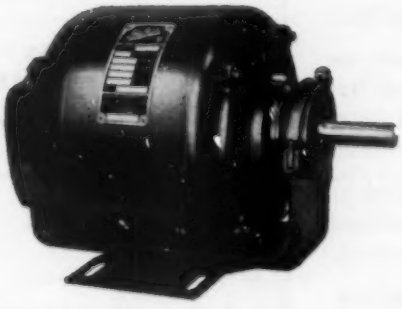
MAKE IT *BETTER*...WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG. CLEVELAND 14, OHIO

THE MOST IMPORTANT PERSON IN YOUR BUSINESS...



is a *satisfied customer!* And one way to assure satisfied customers is to standardize on Packard electric motors for your electrical appliances.

The motors built by Packard Electric have been well and favorably known for 37 years. There is no better fractional horsepower electric motor on the market. So, when you specify Packard electric motors, you benefit in two ways: Your product will give your customers reliable and long-lasting performance; the satisfaction experienced by your customers will be reflected in greater acceptance for your product.

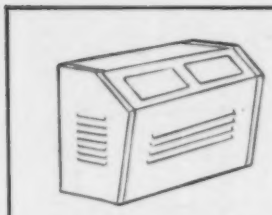
A COMPLETE LINE OF
RUGGED FRACTIONAL HORSEPOWER APPLIANCE MOTORS

GM GENERAL MOTORS

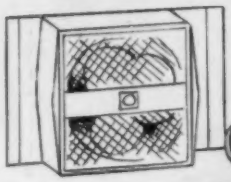
Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors Corporation,
Warren, Ohio



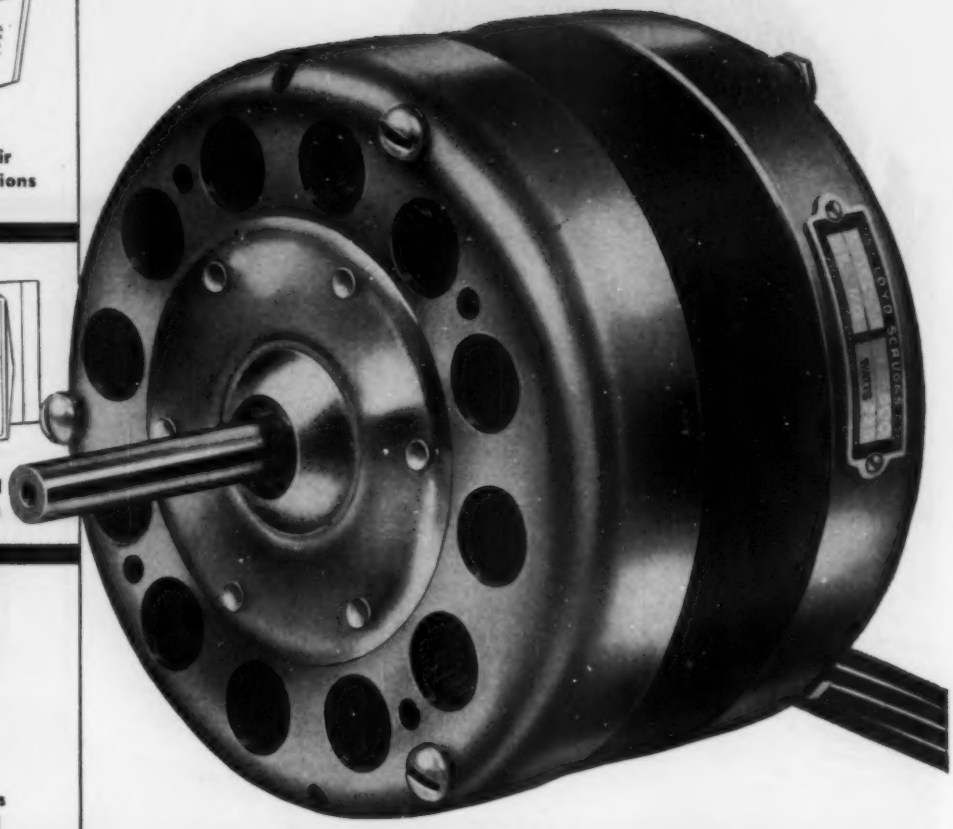
Perfect in room air conditioner applications



Many successful fan applications

?

Potential savings in *your* product!



Look closely...this new LOYD SCRUGGS 6-pole shaded pole motor may be your answer!

The *new* motor shown above is typical of Scruggs' fast-growing versatility in the fractional horsepower motor field.

The precision standards of Scruggs motors, proven in Dictaphones and many other famous products, are more rigid than ever. But new plant facilities at Festus, Mo., now permit faster deliveries, wider scope and very competitive pricing.

If you're searching for a maker to custom-build your motor, search at Scruggs . . . a sample motor made to your specs can be furnished immediately. Send today for detailed data and performance chart.

You can stake your reputation on SCRUGGS MOTORS.

CHECK THESE QUALITY FEATURES:

1. Copper-weld rotor for uniform performance
2. Long-life sintered bronze bearings
3. Extra large oil reservoirs
4. Extremely quiet running
5. Rotor electronically balanced
6. Double varnish impregnated for tough applications
7. Design practically eliminates AC hum

THE Loyd Scruggs COMPANY

Festus, Mo.—A Dazey Corporation Subsidiary

MANUFACTURERS OF PRECISION INSTRUMENTS SINCE 1934

COME SEE...

how Pittsburgh Purple Armored Gears are made

● That little old plant of ours at 27th and Smallman got too small for us so we went "house" hunting. Pictured above is what we found—33,000 feet of floor space with five acres of room for us to spread out. Now we'll be able to give you better service.

● New and better equipment, in addition to equipment from our old plant, is beginning to turn out Pittsburgh Purple Armored Products faster than ever. And our new, enlarged heat-treating facilities will enable us to continue to supply the high quality ARMORED and heat-treated gears ...and allied products...which have been guaranteed by Pittsburgh Gear and accepted throughout the industry as second to none...since 1914.

Come and see us **when you can. Meanwhile, send us your specifications for quotation; or tell us what you need, and we'll design the gears for you. Our engineering department is at your service.**

SPUR
MITRE
HELICAL
HERRINGBONE
WORM GEARS
REDUCERS
CRANE WHEELS

MINING MACHINE GEARS and PARTS for LOADERS CUTTERS LOCOMOTIVES

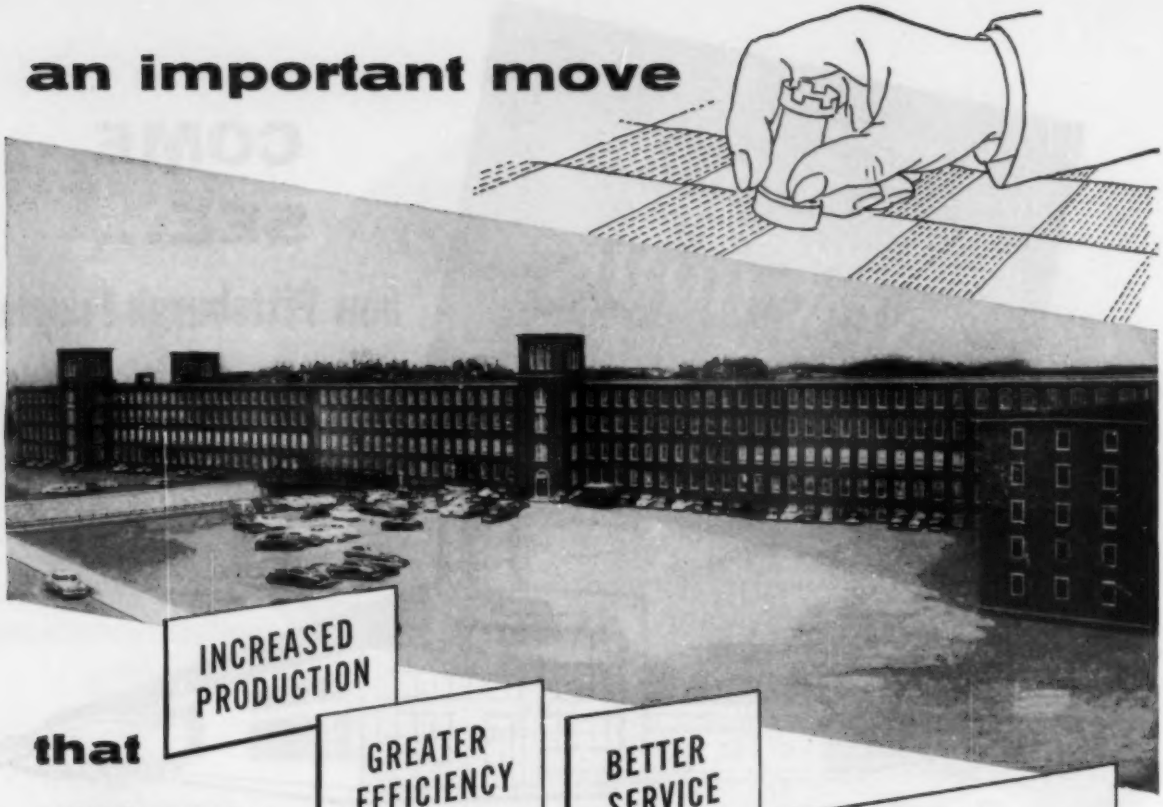
PITTSBURGH GEAR COMPANY

Neville Island
Pittsburgh 25, Pa.
Phone: SPaulding 1-4600

subsidiary of BRAD FOOTE GEAR WORKS, INC. • CICERO 50, ILLINOIS

GUARANTEED PITTSBURGH
ARMORED PRODUCTS
Reg. U. S. Pat. Off.

an important move



INCREASED PRODUCTION

that means — GREATER EFFICIENCY

BETTER SERVICE

FOR EAD CUSTOMERS

Until recently, EAD's expansion was the acquisition of more and more small plants clustered about our main building in Brooklyn. Sooner or later something permanently suitable to our growing needs had to be found . . . and our new plant, in Dover, New Hampshire, is it. Now, under one tremendous roof — with more than 130,000 square feet of working space occupied, and additional space available for future needs — EAD has the elbow room to offer you better service than ever on all your motor and blower requirements. In looking forward to still greater expansion, we recognize the source of our progress — you, our customers and friends — and we shall strive to keep your friendship through constant development of newer and better rotating electrical equipment.

Solving Special Problems Is Routine at EAD

If your problem involves small rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

EAD

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

381 CENTRAL AVENUE—DOVER, NEW HAMPSHIRE

AEROQUIP HOSE LINES with Detachable, Reusable Fittings

Solve Design Problems

Extreme heat, cold, vibration, installation complexities, and other fluid line problems can be solved readily by the application of Aeroquip flexible hose lines. A variety of hose line types in a wide range of sizes and burst pressures meet every industrial need.

Aeroquip hose assemblies can be made right in your plant, *in minutes*, by cutting bulk hose to length and attaching the reusable fittings. An inventory of bulk stock permits the making of individual hose lines for mock up installations or thousands of hose lines for production runs.

Write for complete hose line information. If you want help on a specific problem, a qualified Aeroquip sales engineer will arrange a call.

AEROQUIP 1509 — Aeroquip double wire braid hose for high pressure hydraulic, hot oil, grease, crude and fuel oil, gasoline, and air lines. Pressures range from 5000 p.s.i. in ¼" size to 1000 p.s.i. in 2" size.

AEROQUIP 1503 — Aeroquip 1500 p.s.i. single wire braid hose for medium pressure hydraulic, water, hot oil, crude and fuel oil, anti-freeze solution, gasoline, diesel fuel, and air lines. ¼" to ¾".

AEROQUIP 1525 — Aeroquip 250 p.s.i. triple-ply cotton-reinforced hose with one-piece SOCKETLESS fittings for low pressure hydraulic, water, hot oil, crude and fuel oil, anti-freeze solution, gasoline, diesel fuel, vacuum and air lines. ¼", ⅜", ½", ⅝"

1533 — Aeroquip wire-braid-reinforced butane-propane hose for LPG engine plumbing or for fixed installations where vibration causes problems. This is the only butane-propane hose line listed by the underwriters' laboratories. ¼" to 2".

1524 STEAM — Aeroquip burstproof hose with *"little gem"* fittings for steam cleaning units, dry cleaning and pressing equipment, foundry equipment, plastic molding presses, steam boiler installations, rubber curing and vulcanizing equipment. ½" to 1".

AEROQUIP 1540 — Aeroquip Freon hose for use on automotive and commercial air conditioning units and refrigeration equipment using Freon 12. Sizes are ¼" to 2".

"little gem" is an Aeroquip Trademark

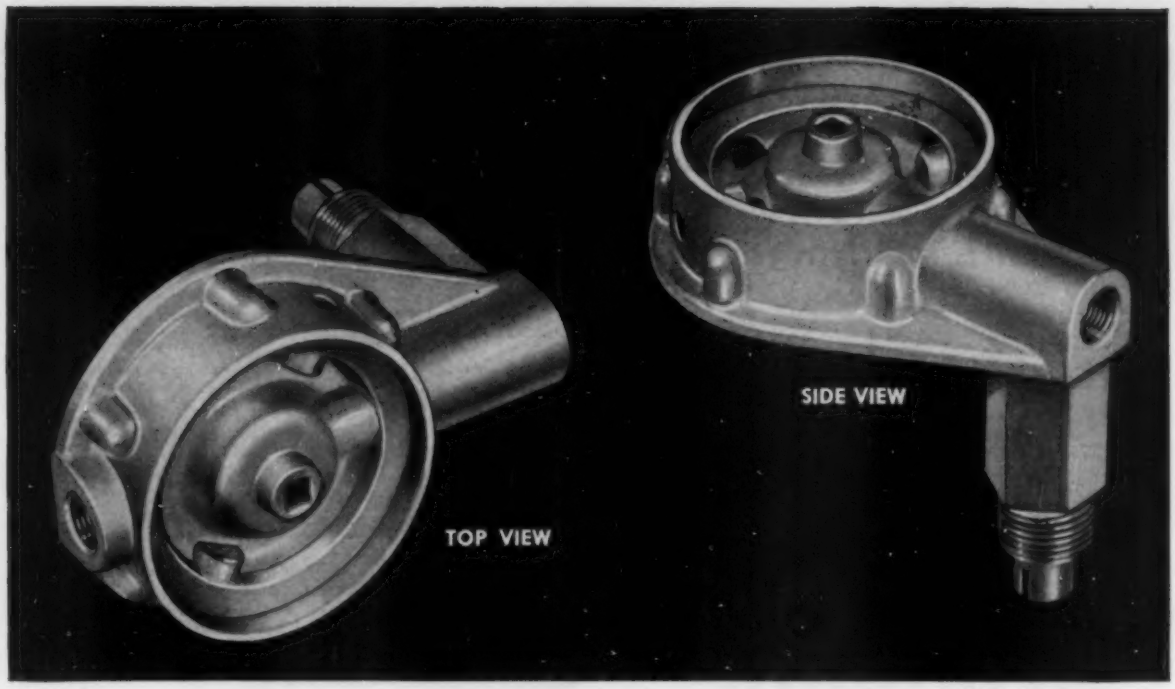
Aeroquip

REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: Burbank, Calif. • Dayton, Ohio • Hagerstown, Md. • High Point, N. C. • Miami Springs, Fla. • Minneapolis, Minn. • Portland, Ore. • Van Wert, Ohio • Wichita, Kans.
IN CANADA: Preco Progress and Engineering Corporation Ltd., Toronto • IN ENGLAND: Super Oil Seals & Gaskets, Ltd., Birmingham

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD



profitable designing with MADISON-KIPP zinc and aluminum die castings

Co-ordinated effort by the part designer and Madison-Kipp produced this Fuel Filter Body which required no machining except tapping and threading. This procedure has often proved highly profitable.

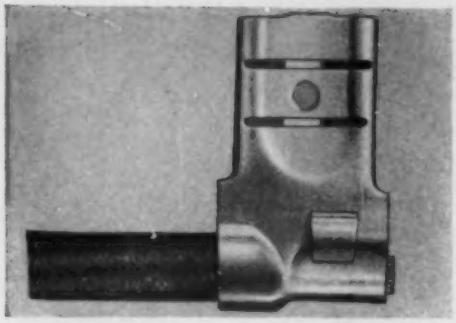
Madison-Kipp has seasoned and skilled mechanics who know that many manufacturing problems can be resolved or at least reduced on the drafting board.

If you think we can be helpful to you, please write us.

kipp

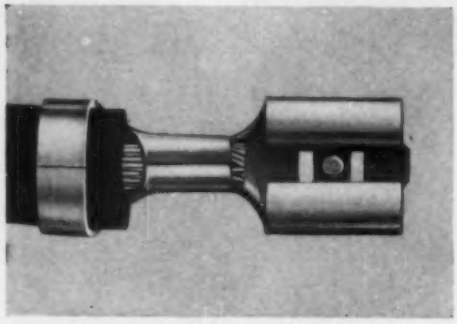
MADISON-KIPP CORPORATION
206 WAUBESA ST., MADISON 10, WISCONSIN, U.S.A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools



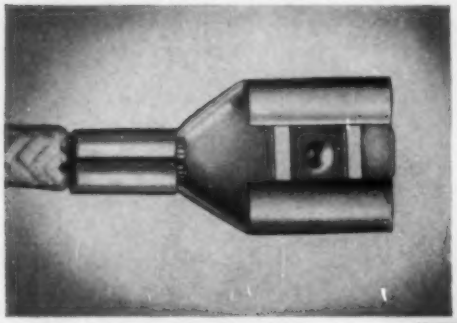
NEW FASTON FLAG FEATURES "TAB-LOK" CRIMP DESIGN

Here is the new A-MP FASTON Flag, the first right angle fast connecting type terminal to achieve electrical characteristics that will meet the most stringent tests without solder. Newly perfected crimp incorporating Locking Tab design and "Keystone Serrations" in inner wire barrel eliminates temperature rise and millivolt drop problems encountered with non-precision crimping methods.



LARGE INSULATION SUPPORT FASTON

Note special offset design which permits this FASTON connector to grip 5/64" wall and large insulation without overstressing the stripped wire or rupturing the insulation. Specially designed to provide perfect grip on heavy insulation U.L. specified wires (#16 to #12 AWG) used in Air Conditioning and Refrigeration Industry. Perfected for insulation diameter range of .210 to .265.



STRAIGHT-ON FASTON SERIES

These quick-to-apply terminals have found wide use in washers, dryers, ranges, refrigerators, and many other electrical appliances. Now available with and without insulation support for wire ranges from #22 to #12 AWG. Standard Stock Line includes terminals in bright dip, tin plated, and silver plated brass for varying corrosive environment and varying temperature requirements.

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

...An evaluation survey without cost or obligation.

now a complete line of AMP FASTON connectors

EASIER, FASTER WIRING AT LESS COST

Precision engineered A-MP FASTON connectors are now available in several new styles rounding out the Complete FASTON Line designed especially for appliance and automotive wiring.

Where space limitations are important, A-MP's FASTON flag terminal (see top left) introduces a reliability never before achieved in a high speed solderless connection of the right angle variety. Four years in development, the New FASTON flag with perfected "Tab Lok" crimp on "Keystone Serrated" wire barrel will pass the most stringent temperature rise and corrosion tests without solder.

To the straight-on FASTON Series (wire ranges now 22 through 12 AWG) has been added the LARGE INSULATION SUPPORT FASTON connector to give perfect support to the wire in the .210-.265 insulation diameter range (as specified by UL for air conditioning and refrigeration products). See left center.

The most recent addition to the A-MP FASTON family is the new straight-on receptacle designed with a 22-20 wire barrel. It provides sure insulation support in the ranges of .090 through .135 outside insulation diameters. Precision engineered for timer leads, appliance lights, etc., it is the perfect answer for wire cost reduction programs.

Write today for more detailed information.

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AMP Trade-Mark
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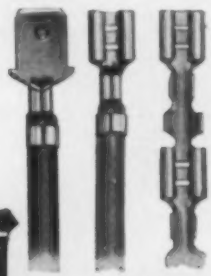
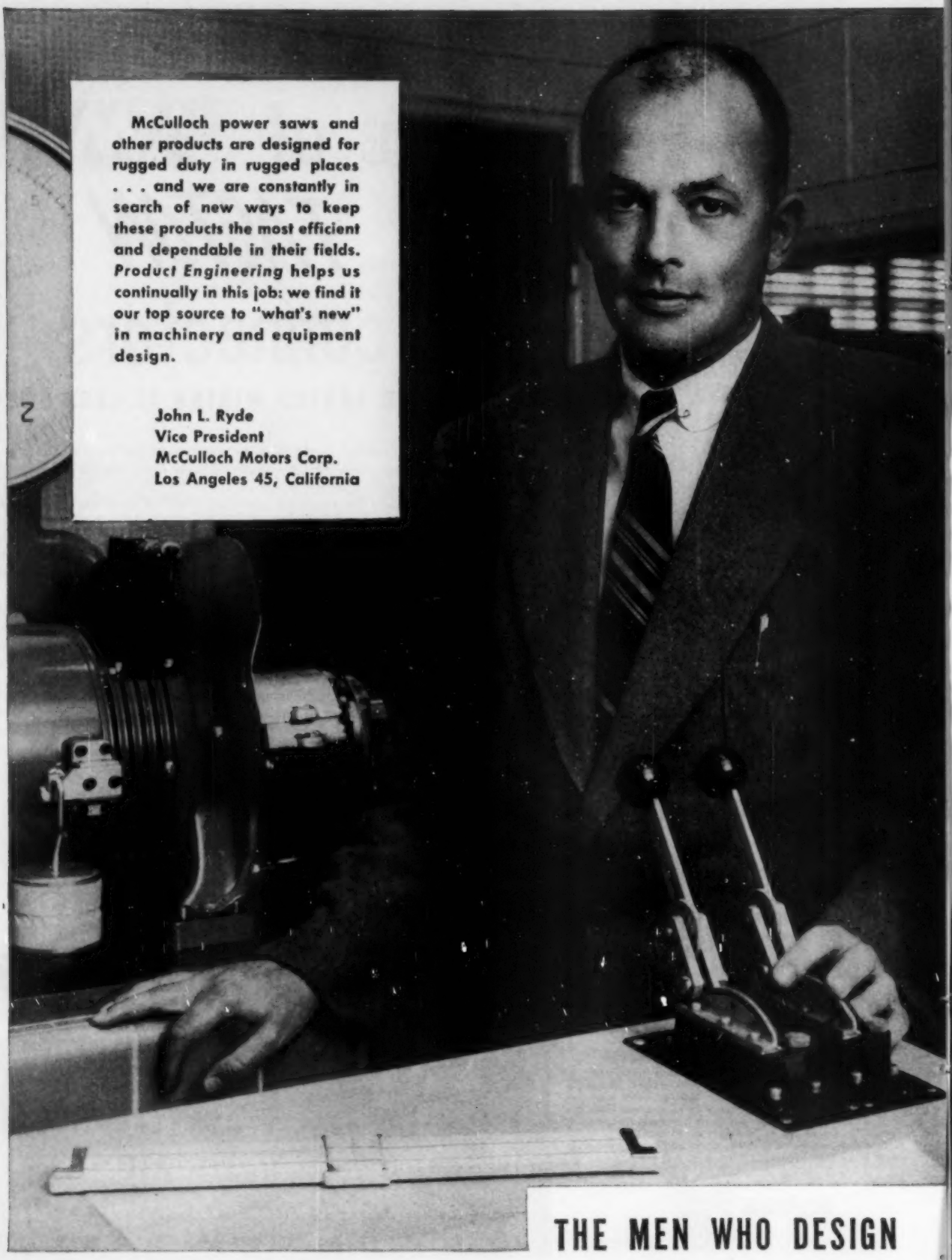


Aircraft-Marine Products, Inc.
2100 Paxton Street, Harrisburg, Pennsylvania
In Canada . . . . Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Road, Toronto 12, Ontario, Canada



McCulloch power saws and other products are designed for rugged duty in rugged places . . . and we are constantly in search of new ways to keep these products the most efficient and dependable in their fields. *Product Engineering* helps us continually in this job: we find it our top source to "what's new" in machinery and equipment design.

John L. Ryde
Vice President
McCulloch Motors Corp.
Los Angeles 45, California

THE MEN WHO DESIGN

He Leads Design at McCulloch Motors

HE READS PRODUCT ENGINEERING

. . . *and if you want your advertising read* . . . by a $28-billion market's basic buying group . . . you concentrate it in this *only* design magazine which can give you the priority attention of 26,000 designers of today's *and* tomorrow's products

If you're as sales-minded as your competitors, and out to be THE LEADER in your field, there's no advertising substitute for the LEADING MEDIUM in the biggest of all markets for parts, materials, components, and finishes.

And in the giant and great-growth Original Equipment Market . . . you can confirm *Product Engineering's* leadership on every count, and do it FAST.

Circulation? Over 26,000 paid subscribers, which is 26,000 *more* than any other general design-engineering magazine offers you in its circulation statement.

Editorial? More than 1,900 pages a year, edited exclusively for design engineers by the biggest and best-qualified editorial staff among design magazines. More pages . . . better edited . . . and better qualified to draw responsive attention to your advertising . . . than you will find in any other design publication.

Advertising? Year after year, successful companies and their agencies invest far more advertising pages and dollars in *Product Engineering* than are invested in any other design-engineering magazine. They *know* that *only* this magazine reaches and penetrates industry's Design-Engineering Headquarters with the impact of an all-paid, ABC-audited, constantly growing circulation.

New-product development is today at an all-time peak, and if you want your sales curve headed in the same direction, make sure you put the power of *Product Engineering* behind your products.

The McGraw-Hill Magazine of Design Engineering

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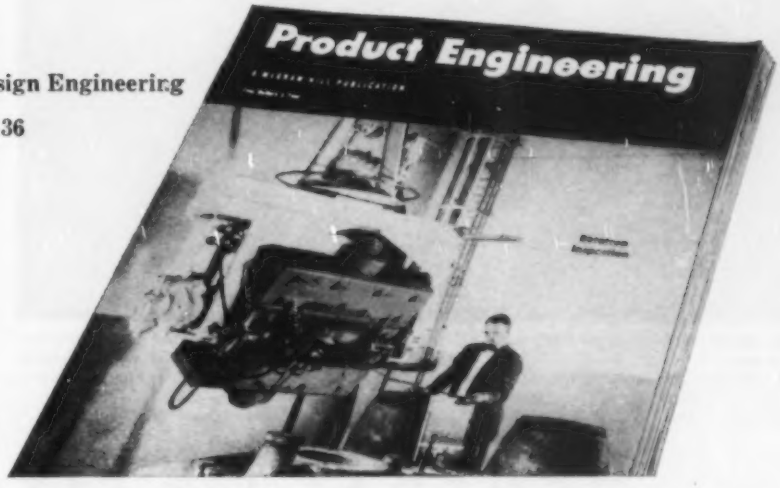
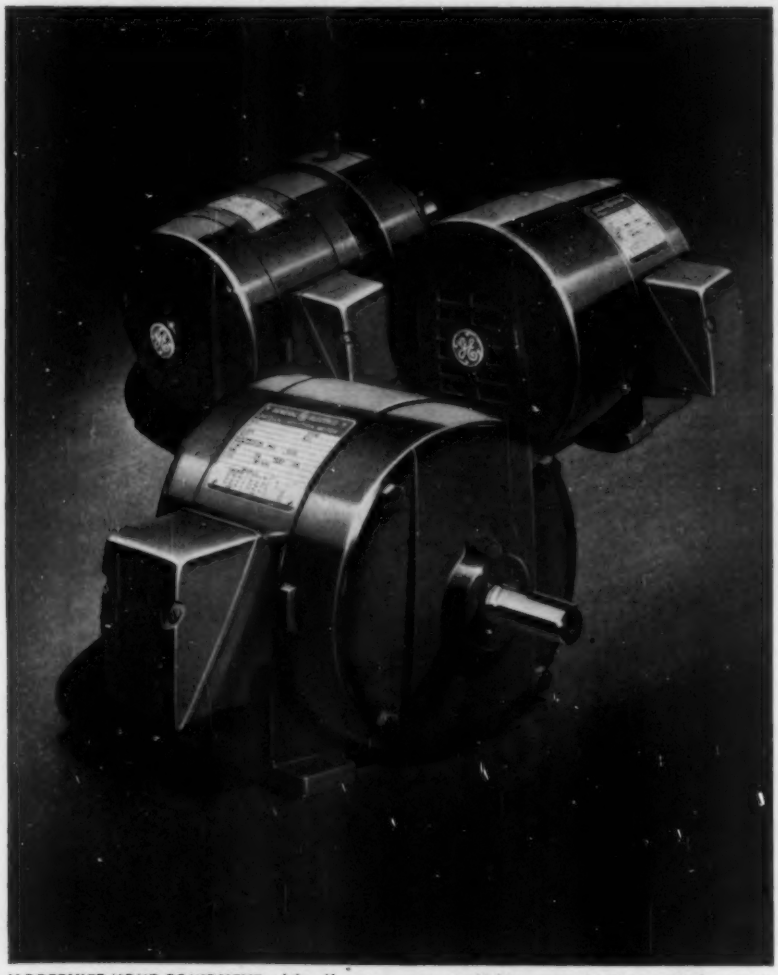


AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

Designer's

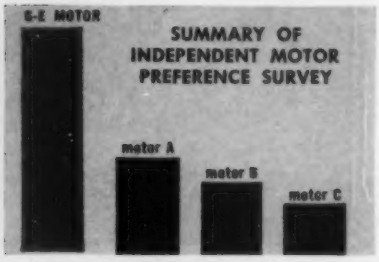
Three good reasons for designing new TRI 55 CLAD motors into your machines

REG U.S. PAT. OFF

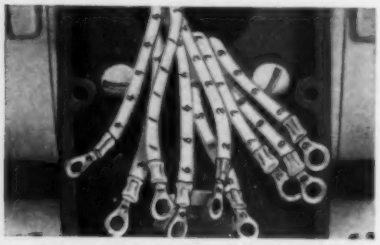


MODERNIZE YOUR EQUIPMENT with all-new General Electric Tri/Clad* '55' motors. A complete line assures you of getting the right electrical drive for your machine. Ratings in new NEMA 182 and 184 frames now available . . . entire line to 30 hp available soon. Check coupon for more information on Tri/Clad '55' dripproof, enclosed, and gear-motors.

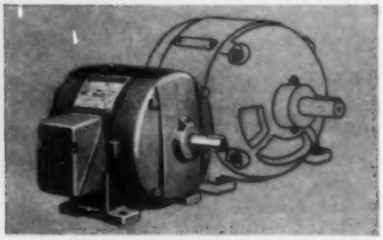
*Registered trade-mark of General Electric Co.



1. **BUYER PREFERENCE.** You take advantage of a 2 to 1 preference for the motors on your equipment when you use G-E motors. Buyers also like the G-E small motor service station plan (Bulletin GEC-972).



2. **EASIER INSTALLATION.** Perma-numbered leads are always easily read even when taped or clipped. Roomier conduit box has plenty of knuckle room. Bolts go in easily, quickly.



3. **MORE POWER PER POUND.** Lighter, smaller Tri/Clad '55' motor—in new NEMA frame sizes and ratings—reduces waste space, saves weight, lowers your handling, shipping costs.

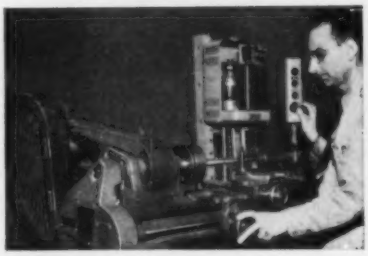
GENERAL ELECTRIC

Digest PRODUCT HIGHLIGHTS

New TSA-18 process timer's small size helps simplify design problems

Accurate, adjustable time-delay opening and closing of electric contacts is provided by the new G-E TSA-18 process timer. With it, designers can add automatic timing to hydraulic presses, tire molds, baking equipment, heat-treating ovens, mixing machines, signals, conveyors, and others. The TSA-18's built-in auxiliary circuits permitting semi- or fully-automatic operation, and its compact size, only 5¾ in. square by 8½ in. deep, make it easily adaptable to a wide range of uses. Weighing only 6¾ pounds, it is easily installed. Bulletin GEC-1223.

Compact Thy-mo-trol* drives give versatile speed control

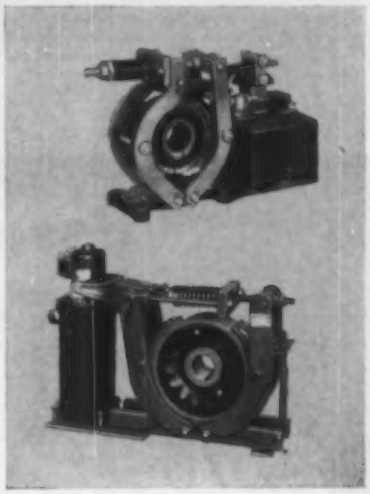


Specify G-E Thy-mo-trol packaged adjustable speed drives for almost limitless choice of speeds within the range. Speed ranges up to 100 to 1 or better are available in ratings from 1/40 to 30 hp. Components are: d-c motor, operator's control station, anode transformer for full-wave types, electronic control panel. Cabling and terminals are plainly marked for easy connection, and the system adapts readily to special drive requirements. It will increase from one operating speed to another in a fraction of a second, and has been service-proved on thousands of machines. Ask for Bulletin GEA-5337.

*Registered trade-mark of General Electric Co.

General Electric a-c brakes give smooth, positive braking at low cost

When CR9516 solenoid and thrustor brakes are designed into machines they add markedly to customer acceptance. Braking torque is adjustable over a wide range. Self-aligning brake shoes help to give smooth, positive braking in either direction. Sturdy, simple construction contributes to its exceptional reliability. Both solenoid and thrustor types are available in three kinds of construction: open, dripproof, and watertight. Long lining life and long wheel life reduce maintenance costs. These G-E brakes are recommended especially for cranes, bridges, turntables, and conveyors, and in machine tool and other rotating-machine applications where continuity of service and low braking cost are important. A hand-operated device for releasing the shoe from the wheel is available in both types. Ask for Bulletin GEA-1518.



Progressive Mechanization program widens market for your machines

General Electric's More Power to America Program "Progressive Mechanization" can help promote your machine sales because it is directed to your customers. The aim of this program is to show them how they can increase production and reduce costs through a progressive step-by-step mechanization of their operations. The program includes a manual and a color sound motion picture, "Motors in Industry," which dramatizes the importance of improved mechanization. For a complete description of the program, write for Bulletin GEA-5789. If you would like a showing of the film, call your nearest Apparatus Sales Representative.

General Electric Co., Apparatus Sales Division, Section A668-115, Schenectady 5, N. Y.

Please send me the following bulletins: √ for reference X for immediate project

- ☐ GEA-6012 Tri-Clad '55' Enclosed Motors
- ☐ GEA-6027 Tri-Clad '55' Gear-motors
- ☐ GEA-6013 Tri-Clad '55' Dripproof Motors
- ☐ GEC-972 Small-motor Service Station Plan
- ☐ GEA-1518 CR9516 AC Brakes
- ☐ GEC-1223 Process Timer
- ☐ GEA-5337 Thy-mo-trol Adjustable-speed Drives
- ☐ GEA-5789 Progressive Mechanization

CONSULT YOUR SWEETS PRODUCT DESIGN FILE. You'll find "everything electric" for machinery manufacturers in the General Electric Section.

NAME ..... COMPANY .....

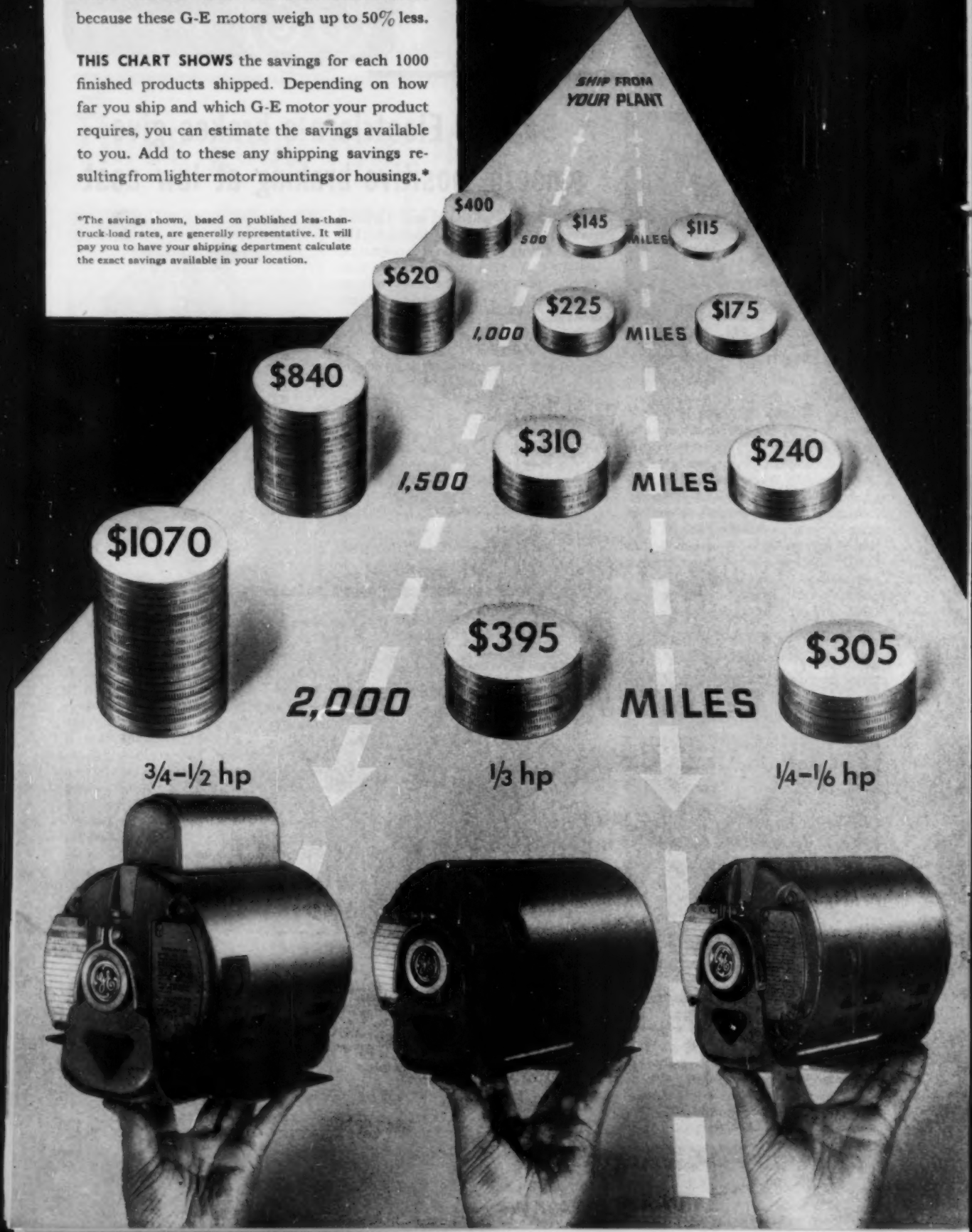
CITY ..... STATE .....

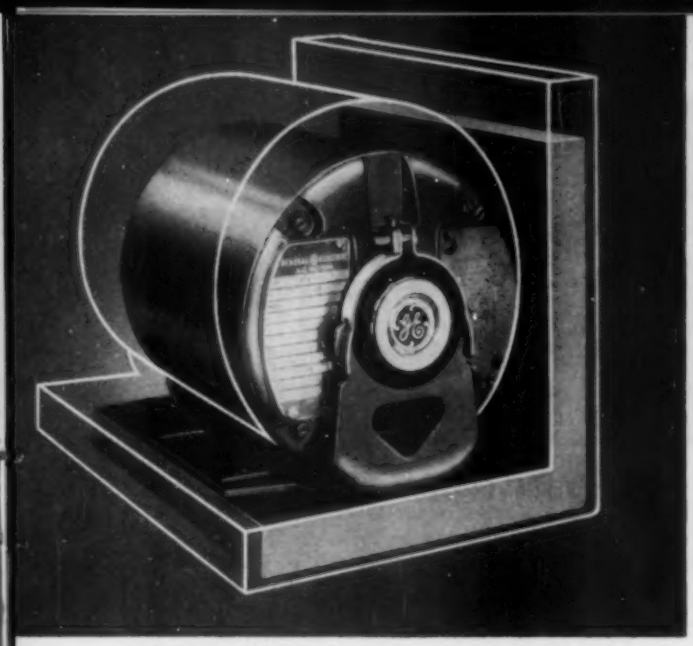
YOU SAVE ON TRANSPORTATION

because these G-E motors weigh up to 50% less.

THIS CHART SHOWS the savings for each 1000 finished products shipped. Depending on how far you ship and which G-E motor your product requires, you can estimate the savings available to you. Add to these any shipping savings resulting from lighter motor mountings or housings.*

*The savings shown, based on published less-than-truck-load rates, are generally representative. It will pay you to have your shipping department calculate the exact savings available in your location.





YOU SAVE ON MATERIAL COSTS because new G-E motors—as much as 50 percent lighter, 40 percent smaller—permit you to design smaller and lighter motor mountings and housings.

YOU SAVE ON ASSEMBLY COSTS because your assembly-line personnel will produce more efficiently with less fatigue since these General Electric motors are far easier to handle.

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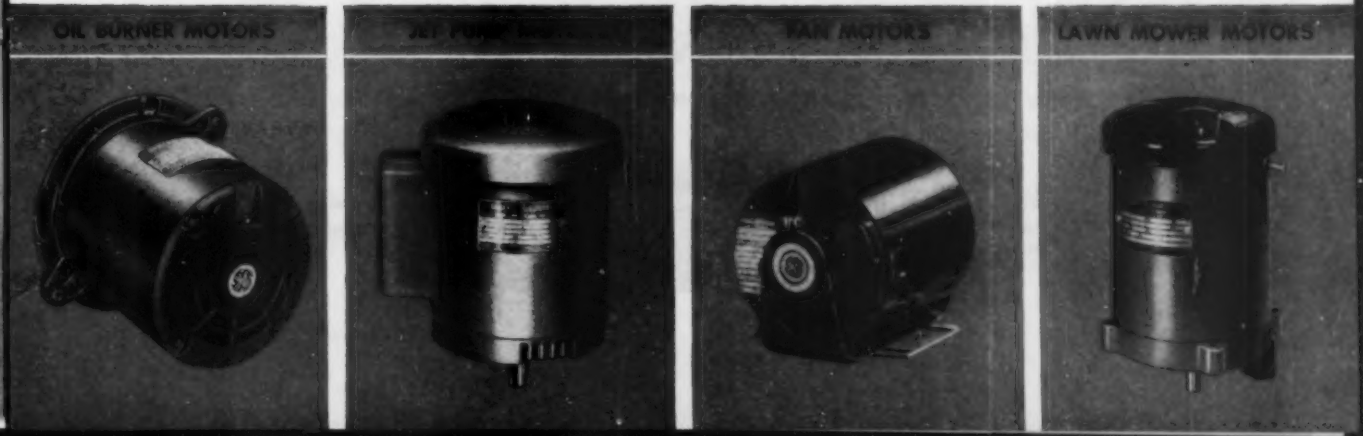

balanced △ design

BALANCED DESIGN . . . adds to the life of Philadelphia Herringbone Gears and Speed Reducers. In addition to the Sykes continuous tooth, Philadelphia also manufactures Staggered or Separated tooth gears of the Herringbone type in sizes up to 150 inches diameter. For heavy duty industrial drives, the Herringbone Gear provides maximum efficiency and economy.

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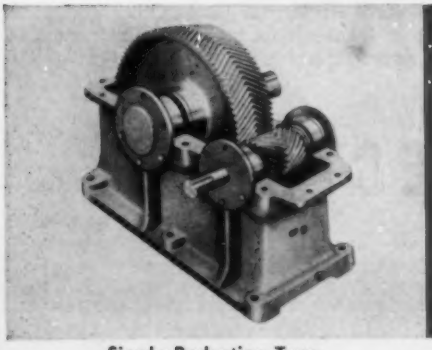
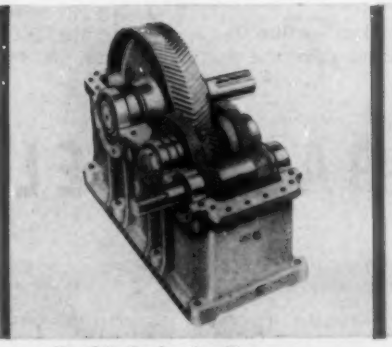
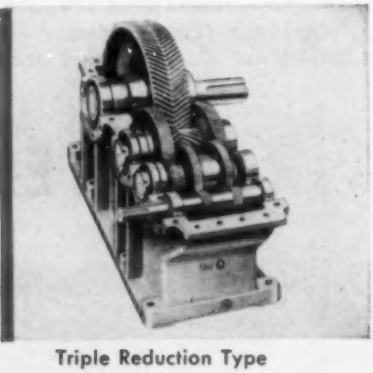


Single Reduction Type



Double Reduction Type



Triple Reduction Type

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Perspectives

DESIGN AND DEVELOPMENT

PLASTICS GET ANOTHER CHANCE

Just a few years ago the Plastics Industry burned its fingers when it permitted anybody owning a few pieces of production equipment and a small garage to set himself up in business. To make a fast dollar, these neophytes downgraded the material, with the result that the market was glutted with products of inferior quality, and consumers in a very short time got the impression that any thing made of plastic was worthless. But, with the concentrated efforts of the materials suppliers since then, the Industry now stands in a respectable light, and at the moment, it has a lion by the tail in the form of a mushrooming business of plastics for tooling.

Before the year is out, 5 million pounds of plastics will have been used for tooling alone. This figure is about equally divided between phenolics and epoxies, the two resins most used for tooling. Polyesters are also used, but to a lesser degree. In 1956 the estimate is 14 million pounds, with epoxies receiving the lion's share. In 1960, the three largest producers of epoxy resin have estimated that combined, they will be making 20 million pounds of this resin for tooling alone.

BIG USERS

To date the big users of plastic tools are the Aircraft and Automotive Industries. Here the applications are primarily metal forming, with stretch and draw dies, drop hammers, and stamping dies made of plastic. There are other uses like checking, spotting, drilling, routine fixtures, drill jigs, and holding fixtures. Foundries find plastics useful as core boxes, patterns, and match plates. Compiling figures from aircraft manufacturers, it is safe to say that at least 50 per cent of the dies used are made of plastic. One company flatly states that almost 100 per cent of their stretch-press tooling is plastic. Others say, "Many of the old metal tools are still with us, and we aren't throwing them out. But they are gradually being replaced with plastic. The plastics we now know of, we are exploiting as fully as possible. Undoubtedly we will learn more, and are ready to use plastics much more widely as soon as it is feasible."

Estimates of plastic die use in the automobile industry have been as high as 20 percent, but not too many will either confirm or deny this. For the most part they are being used in low-volume production, with some being considered strictly experimental. Door panels, gas tanks, truck panels, and truck cab tops are a few of the parts named as having been made with plastic dies. But one viewpoint is definitely apparent. Frequent changes in car styling on low production models will be possible, and the cost of sports cars and luxury models will be reduced. It may also mean that the customer of the future will have a greater variety of car styles from which to choose. Also, the gap between model changes will be narrowed.

(Continued on page 125)

THIS MAN PROVES FLEXON BELLOWS BEFORE THEY GO INTO SERVICE

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Here is just one of the quality control procedures followed at Flexonics to be sure that Flexon Bellows delivered to you are right. With a mass spectrometer and a shot of helium gas each bellows is proved to be leakproof before it is released. Other quality control tests prove all the critical characteristics required for top notch performance in your product. Coupled with Flexonics Corporation's extensive laboratory facilities for proving design before manufacture, it assures you of top quality bellows that meet your specifications exactly and do their job the way you want it done.

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Perspectives

ADVANTAGES AND DISADVANTAGES

The main advantage, of course, is cost; with a 50 percent saving on tool cost, and a 70 percent saving on the time required to make the tool. But comparing the cost of plastic and metal dies depends on several factors: complexity of deformation of the part; type of material being formed; material from which tool is made; tolerances required; type of equipment available. Plastic dies have been used successfully on 0.030 in. stainless and 3/32 in. aluminum, however, it is not recommended to anything heavier than 0.060 steel. This, too, depends on the configuration of the part, with radii under 3/32 in. not recommended. But plastic dies are cheaper (by comparison with metal) the more complex the part. The overall size of the die, too, is to plastic's advantage. The lower cost of plastics makes it possible for the aircraft industry to use the large dies it could not otherwise afford, because of the short runs (normally only 300-400 parts). In making plastic dies, practically all the grinding is eliminated, while for a large metal die 3 to 4 ft. wide by 8 to 12 ft. long, it is not unusual to spend $1,000 to $2,000 on grinding alone. A plastic face can be completely poured in eight hours.

MATERIALS USED

The materials for plastic tooling include phenolic, polyester, and epoxy resins. The cost per pound is $0.50 for both phenolic and polyester resins. Epoxies, on the other hand, because of the different types available, range from $0.70 to $1.60 per pound when bought by the carload. The phenolics are the old standby, having been in use for several years. But the newest are the epoxies, which are largely replacing the others because of their versatility. They are stable, can be made to any degree of hardness, and have no tendency to warp, as the polyesters do. The main disadvantage of the phenolics are brittleness and low impact strength. True, both polyesters and phenolics are cheaper in original cost, but the durability of the epoxies make them cheaper in the long run. As a good example of the epoxy strength, Chrysler has just announced the use of new plastic dies capable of withstanding poundings of 20,000 psi. They are now in the production line stamping out parts for Dodge truck bodies.

Some dies are solid cast blocks, while others are laminated to give added strength. But many consist of heavy cores faced with plastic. For example: drop hammer dies are Kirksite and lead faced with epoxy; stretch press dies are phenolic with steel base and reinforcement . . . . sometimes a concrete core is used. The result is a savings in plastic. There are various filler that can be used. Silica, for instance gives a very hard surface, but also an abrasive one. Powdered aluminum is also used. Chipped dies can be quickly repaired, without removing it from the press, with plastic filler . . . allow it to set, and sand smooth.

THE RIGHT WAY

The Plastics Industry is the first to realize the immensity of this new field. It also knows that plastics can be misused here. So, the materials suppliers, the compounders, and the die makers will be the first to tell how to make the dies, and where they cannot be used. All indications seem to point up a healthy respect for experiences gained in other developments.

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TINNERMAN PRODUCTS, INC., Box 6688, Department 12, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners, Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine).

Where to Next?

THE ENGINEERING SOCIETIES' BUILDING, 29 West 39th St., New York City has been or is to be sold. The next step is to decide where the new home of the engineering societies is to be. Already a number of voices are being raised expressing preference for some city or other. But strange as it may seem, the bulk of the membership does not seem to be much concerned about the new location of the Engineers' Building. At least that is what is indicated in a recent leaflet distributed by the Metropolitan Section of the American Society of Mechanical Engineers.

In view of the broad geographical distribution of the engineering societies' membership, it would be impossible to locate the building to suit everybody's convenience. Many members, perhaps most, will express a strong preference for a location that will be easy to get to from their home city. It is perhaps for this reason that the members of the A.S.M.E., New York Metropolitan Section are making efforts to keep the society headquarters in New York.

Although there are quite a few good reasons for having the engineering societies' headquarters in New York City, there are also many conditions that make New York City one of the least desirable places for the headquarters of our engineering societies. Of course in New York City are the main offices of most of the large corporations. There are more hotel rooms in New York City than in any other city in the world. Also there are more taxis, fine railroad terminals and air fields.

Besides the essential utilities and accommodations, New York also can boast about beautiful parks, public buildings, theatres, a splendid harbor, ocean going steamers to behold and innumerable other attractions for visitors. But there are also many detractions.

Because commuting service is often poor other than during rush hours, many engineering society members living in New York suburbs find it practically impossible to attend society meetings unless they stay in a hotel in New York over night. These men find it so inconvenient and expensive to attend meetings in New York City that they don't attend. That is the largest single factor that explains the poor attendance at engineering society local meetings held in New York City. Regional meetings in other cities get a relatively far greater attendance.

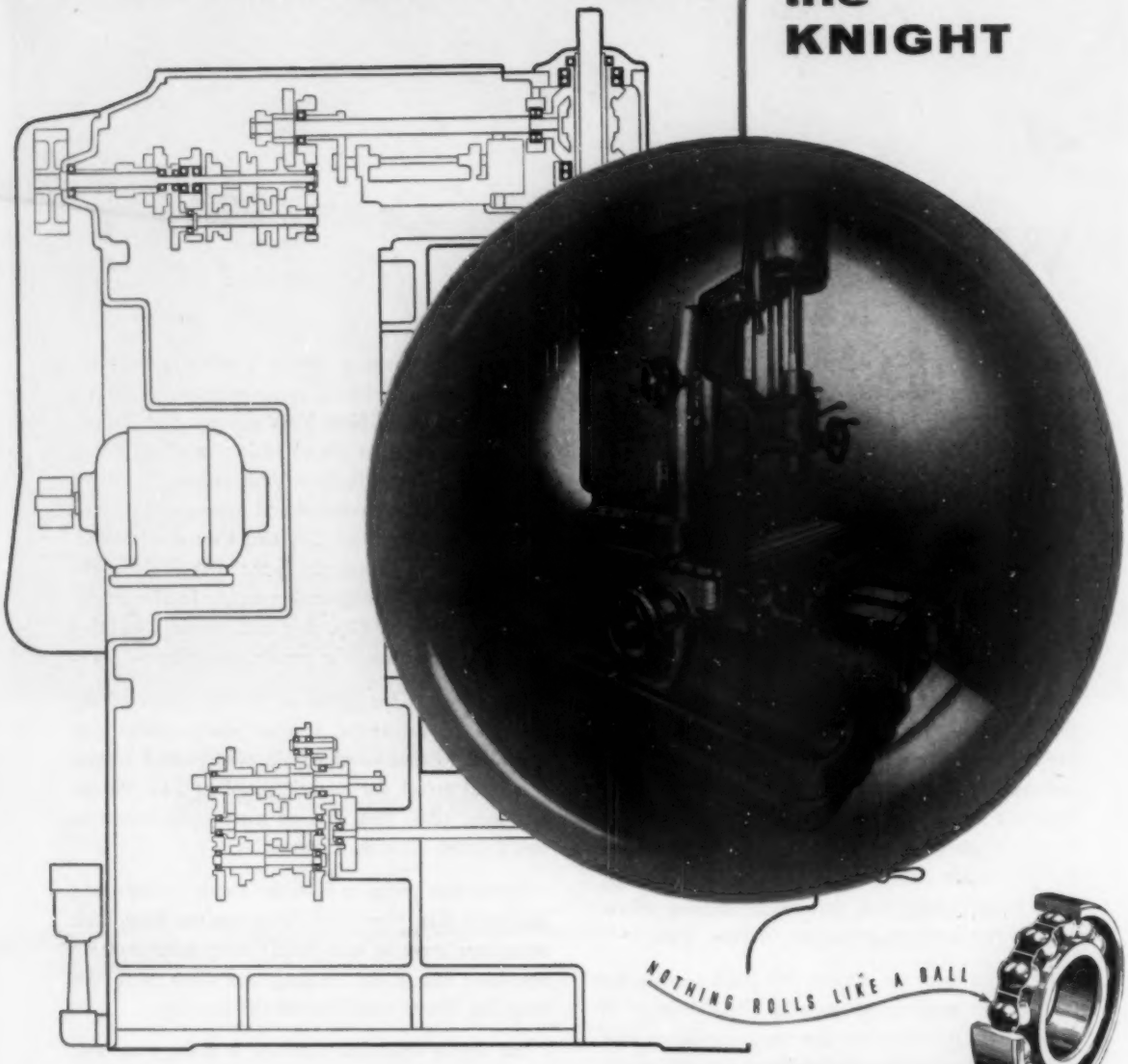
In so far as the operation of the affairs of the societies are concerned, a more nearly central geographical location of the main office would require less total travel for council members and officers. But some claim that it is no more inconvenient to travel 2,000 miles than 200 miles.

Those who prefer to have the society headquarters elsewhere than New York claim that the New York attractions serve to lure people away from meeting sessions. But if the alluring attractions were not available, fewer would attend the meetings.

No matter what final selection is made, there will be those who will be disgruntled over the choice. And it is highly probable that the most loudly disgruntled ones will be those who failed or refused to express their preference in the matter. A one sentence statement addressed to the executive secretary or president of your society is sufficient to put your choice on record.

George F. Rodenbach

NEW DEPARTURES AT WORK all through the KNIGHT



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SYRACUSE	2360 James St.	73-5195	**CHICAGO**	332 So. Mich. Ave.	Wabash 2-5875	**SEATTLE**	5000 First Ave., S.	Lander 5920
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Typical parts produced as impact extrusions illustrate the variations in size, shape and cross section that are now possible.

A Closer Look at
Impact Extrusion

KEITH WILHELM
Lockheed Aircraft Corp.

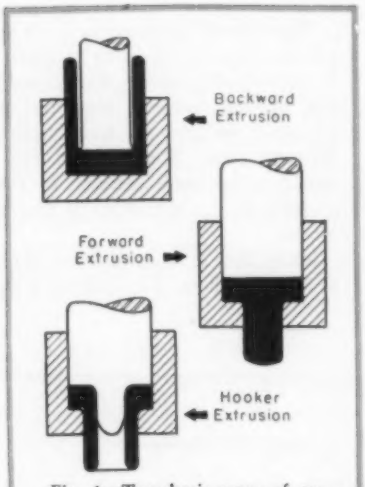


Fig. 1—Two basic ways of extruding are forward and backward. The Hooker method is a variation of forward extrusion.

EXTRUSION BY IMPACTING is similar to other methods of plastic working metal, but it differes from them in several respects. First, impacting is done on a cold blank or, if the blank is heated, the temperature is kept below the critical or hot working range. Secondly, the material flows under pressure and unlike drawing, it is never stretched or moved by tension. It is similar, in effect, to swaging although only a single blow forges the material, and also to coining, except that the material moves much farther.

There are two basic ways of extruding: backward and forward. In the backward method, material is forced through the die in the same direction as the punch travels. A variation of forward extrusion is the Hooker method where the punch guides forward flow through the die and can be used for producing thin walled parts with or without bottoms, Fig. 1. Forward extrusions have an advantage over the backward type in that length of part is limited only by the length of the press stroke; this is to allow removal of the part. Backward extrusion, however, must be used when complex-bottom parts are desired.

Cost-wise, impacts are best when production quantities are large. But the break-even point may be below one

Table I—Typical Properties of Impact Extruded Material with 60 Percent or Greater Reduction in Area in Psi.

Material	Ultimate Strength Annealed Blank	Ultimate Strength After Extrusion	Ultimate Strength After Extrusion and Heat Treat
3SO	16,000	32,500	
61SO	18,000	32,500	45,000
14SO	27,000	45,500	65,000
75SO	33,000	47,500	78,000
1020	55,000	120,000	

thousand pieces if casting is not a practical alternative. Hence, in applications where a high strength to weight ratio is paramount, as in most aircraft components, extruded aluminum parts have proved to be profitable even though quantities required were relatively small.

The advantage of impact extruding over drawing is that in impact extruding, thin-walled parts may have heavy complex bottoms. Also there is a higher percentage of raw material utilization. Very little material is lost in the preparation of the blank and only trimming to length is required to produce a finished part. Some manufacturers cast their blanks, which saves even the scrap due to sawing. As long as the cast blanks do not pick up inclusions, the shrinkage is not objectionable. Tooling is usually cheaper than for drawing, but must be determined for each individual case.

Probably the most important advantage is that of eliminating secondary operations. Tolerances can be held fairly close in intricate shapes, which would require broaching or machining, can be produced in a single operation. In the walls of the part, longitudinal ribs, splines, or serrations can be incorporated and in the base, pads, bosses, stems or even embossing can be included.

Normal design requires a reasonably symmetric cross-section to allow material to flow equally to the walls and to prevent side loading of the punch. The base of the part need not be as symmetrical as the walls, but if a heavy pad is placed eccentrically on a thin bottom, material will flow in the path of least resistance and the walls adjacent to the thin portion will not fill properly. In general, symmetry is not as much of a problem in forward as it is in backward extrusions. On occasion, unsymmetrical backward extrusions have been produced; these were accomplished by keying the punch with the die to resist side thrust.

Material and Physical Properties

All the common wrought aluminum alloys except 24S can be extruded as well as many magnesium and steel alloys. Table I lists several of the more commonly used alloys and gives typical data for their strength before and after forming.

The easiest materials to extrude are those with the lowest tensile strengths; as the tensile strength increases, so does the extrusion pressure.

For a 60 percent reduction in area the extruding pressure for backward extrusions is approximately:

30 tons per sq in. for 2SO & 3SO Aluminum
45 tons per sq in. for 61SO Aluminum
55 tons per sq in. for 14SO Aluminum
60 tons per sq in. for 75SO Aluminum
120 tons per sq in. for 1020 Carbon Steel
140 tons per sq in. for 1030 Carbon Steel

Although a part being extruded is subject to localized heating, the physical properties of the finished piece show cold worked characteristics. Parts with reductions in area greater than 60 per cent tend to work harden to the full hardenability of the material. Areas which are not subject to grain flow, such as corners or bases, do not benefit as much from cold work and do not show this gain in strength. Parts with less than 60 percent reduction in area may not show much gain in physical properties even in the walls. For this reason, when low reductions are made and high strength required, heat treatable alloys are used and subsequently heat treated. In steels, because of the severe cold working, it is sometimes advisable to temper the piece at about 600 F to stress relieve and increase ductility.

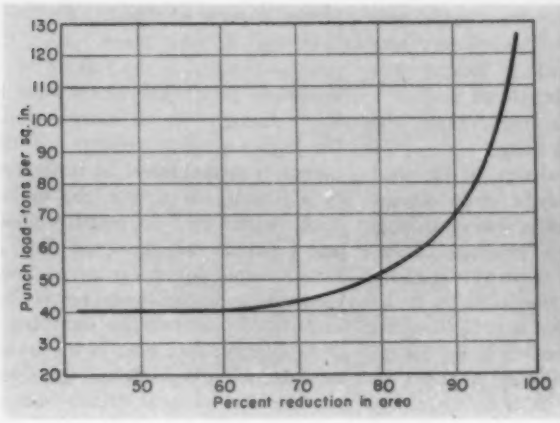
Because the grain structure follows the contour of the finished part, the physical properties of impacts compare favorably with those of forgings. Adding to this the fact that impact extrusions cost far less to produce, the process is in a desirable competitive position economically and functionally.

Manufacturing Limitations

The scope of applications is not limited so much by intricacies of shape as by several other factors, such as reduction in area, pressure, minimum and maximum dimensions, and length-to-diameter ratio. The curve in Fig. 2 indicates the rapid increase in press pressure as the reduction in area increases.

Metal flow is in many ways similar to hydraulic flow. To maintain a flow

A general indication of what can be done with latest methods and currently available equipment was given in *Product Engineering*, April 1954, pages 173 through 175. The present article goes into further details of the process as they affect design engineers. Included are data on such topics as materials, properties, sizes, tolerances, and surface finish.



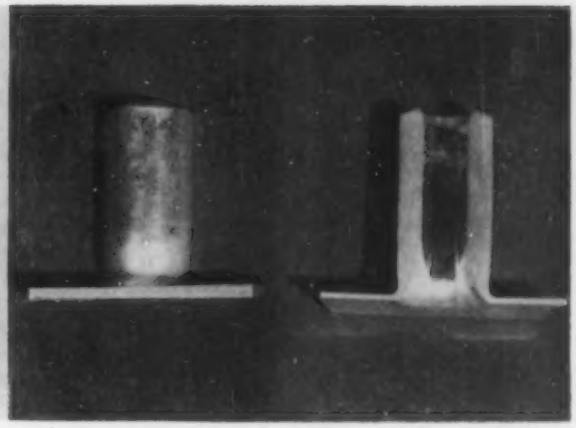


Fig. 2—(Left) Curve showing increase in pressure required for extruding as percent reduction in area increases. For a given part, the section having the largest reduction in area (ratio of the blank area to section area) determines the required press capacity. Fig. 3—(Right) When flange thickness decreases to a value below the wall thickness starvation of the walls may occur as shown.

of fluid past an obstruction requires more pressure than moving the same quantity through an unobstructed section. The same appears to be true for metal, and since the punch speed cannot be varied, the rate of material displacement is also invariable. Thus, parts which are designed with constrictions will cause extrusion pressures to rise. Wall thickness affects pressure when it drops below 0.12 inches. The pressure rises as the wall becomes thinner, and a 0.04 in. wall may require 50 percent more pressure than a 0.12 in. wall.

With this in mind, it can be seen why steel impact extrusions should be kept simpler in configuration than aluminum impacts. The pressure to extrude steel ranges from 240,000 psi up, and any configuration with high reduction in area, thin walls, steps or constrictions, would bring the pressure above the strength of the tooling. (Tooling yield strength is approximately 350,000 psi.) Tooling must also be designed without sharp corners or projections, for stresses concentrate at these points and they become areas of tool failure.

Sizes and Tolerances

Pressures reach a prohibitive stage with reductions of over 90 percent. Because of high pressures when backward extruding, the punch suffers from a column effect and to keep it from deflecting and buckling a maximum length-to-diameter ratio has been established. This slenderness ratio for the punch is 6 to 1 for the softer aluminum alloys, 4 to 1 for 14S and 75S and 3 to 1 for steels. As mentioned previously, forward extrusions can be produced to almost any desired length; parts with the length more than one hundred times the diameter have been made on a production basis.

Minimum wall thickness of a part can be as thin as 0.015 in. for 2S aluminum, but should not be less than 0.040 in. for 14S and 75S, or 0.060 in. for steels. Thickness of the bottom for backward extrusion, or the flange for forward extrusion, should not be less than the adjacent wall thickness, as the bottom thickness approaches wall thickness, a pressure build-up occurs and in addition, material starvation takes place at the base of the walls, Fig. 3. A recommended bottom minimum is 0.125 in. for 75S and 14S aluminum and 1½ times wall thickness for all aluminum alloys.

A thick bottom also is a definite aid in getting the extrusion to remain in the die where it can readily be ejected. When the inside diameter of an impact extrusion is 3 inches or greater it is advisable to introduce a slight taper on the bottom of the part to facilitate flow of the metal and reduce punch wander. The internal radius at the base is not particularly critical but a 0.06 radius is recommended.

Tolerances on impact extruded parts compare favorably to machined parts. Part width can be kept well within ± 0.010 in. and wall thickness to ± 0.005 in. Bottom or flange thickness will depend upon the consistency of the press stroke and ± 0.010 in. should suffice. The length of the extruded part depends on the thickness of the blank, bottom thickness variation, and the amount of reduction in area; ± 0.12 in. is a typical value.

Surface finish ranges from 40 to 250 microinches, depending on variables existing during extrusion. Poor surface condition of the blank will result in the finished parts exhibiting scores, surface checks, and gall marks. Lack of lubrication or excessive amounts of it will also have a detrimental effect on surface finish, as will sharp edges on the back side of the punch land or excessive relief on the punch.

Although most aluminum impact extrusions are circular in cross section, it is possible to produce square and rectangular sections. From the standpoint of die life, a 0.22 in. radius is recommended for vertical external corner even though parts with a 1/32 radius can be produced satisfactorily. Vertical inside corners should have a 1/32 radius. A sharp corner will cause the material to bind and gall and lap over at the corners. When forward extruding, it is necessary to allow a radius to the entrance of the die, the radius ranging from 0.06 to 0.19 inches. As shown in Fig. 4, this facilitates the flow of material into the die.

Use of Inserts

Frequently, because of localized wear points on a part, it is necessary to make a complete part from steel. This, of course, results in increased weight. To save weight, aluminum im-

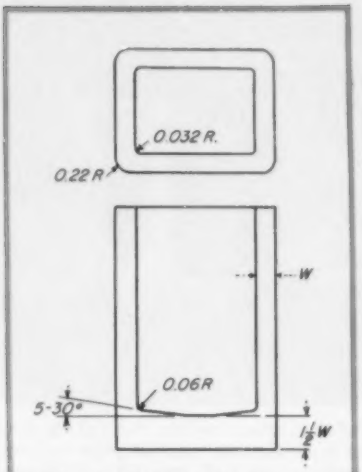


Fig. 4—Design limitations for aluminum alloy boxes to be produced as impact extrusions.

pact extrusions have been made with steel inserts. These inserts may take the form of a bushing located in a bore, a stud at the closed end of a tubular part, or a ring forming the outer portion of a flange.

By varying the design of the steel insert, the joint may be made to resist tension, compression, or torsional loads. Any of the extrudable aluminum alloys can be used with steel inserts, but f the aluminum is to be heat treated, the joint must be designed so that the steel insert will not loosen after the heat treatment. A part with a thin steel ring is not satisfactory for heat treatment, as the expanding aluminum will stretch the steel ring, and on cooling the ring will be larger than the adjacent aluminum. Since a corrosion problem exists when steel is in contact with aluminum, steel inserts should be cadmium or nickel plated or made of stainless steel.

Design of the insert poses the greatest problem in the making of an acceptable joint. The insert must be heavy enough not to collapse under the high extruding pressure. If this cannot be accomplished, as in the case of a bushing in a bore, the tooling must be designed to permit smooth and relatively uninterrupted flow of the aluminum during extrusion. Sharp corners or undercuts should be avoided, as they will trap material and cause it to shear if the flow lines of the aluminum are disturbed. When the insert must resist directional stresses, such as torsion, it should be designed with ears or splines to prevent rotation. If properly designed, a joint can have a strength of 60-80 percent of the sheer strength of the base material. Detail machining on steel inserts may be done before or after assembly.

Fig. 5—Double impact extrusion: Extruded forward and backward simultaneously.

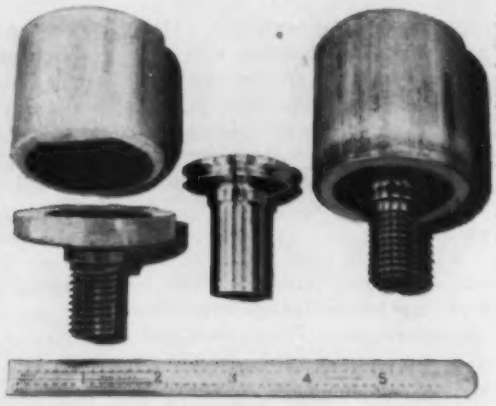


Fig. 6—Aluminum fitting with steel insert failed in tension (left) at 15,700 lb. Three parts (below) show thin flanges and rectangular shapes can be produced as well as circular sections.

Fig. 7—Impact extruded aluminum parts with integral steel rings and flanges.

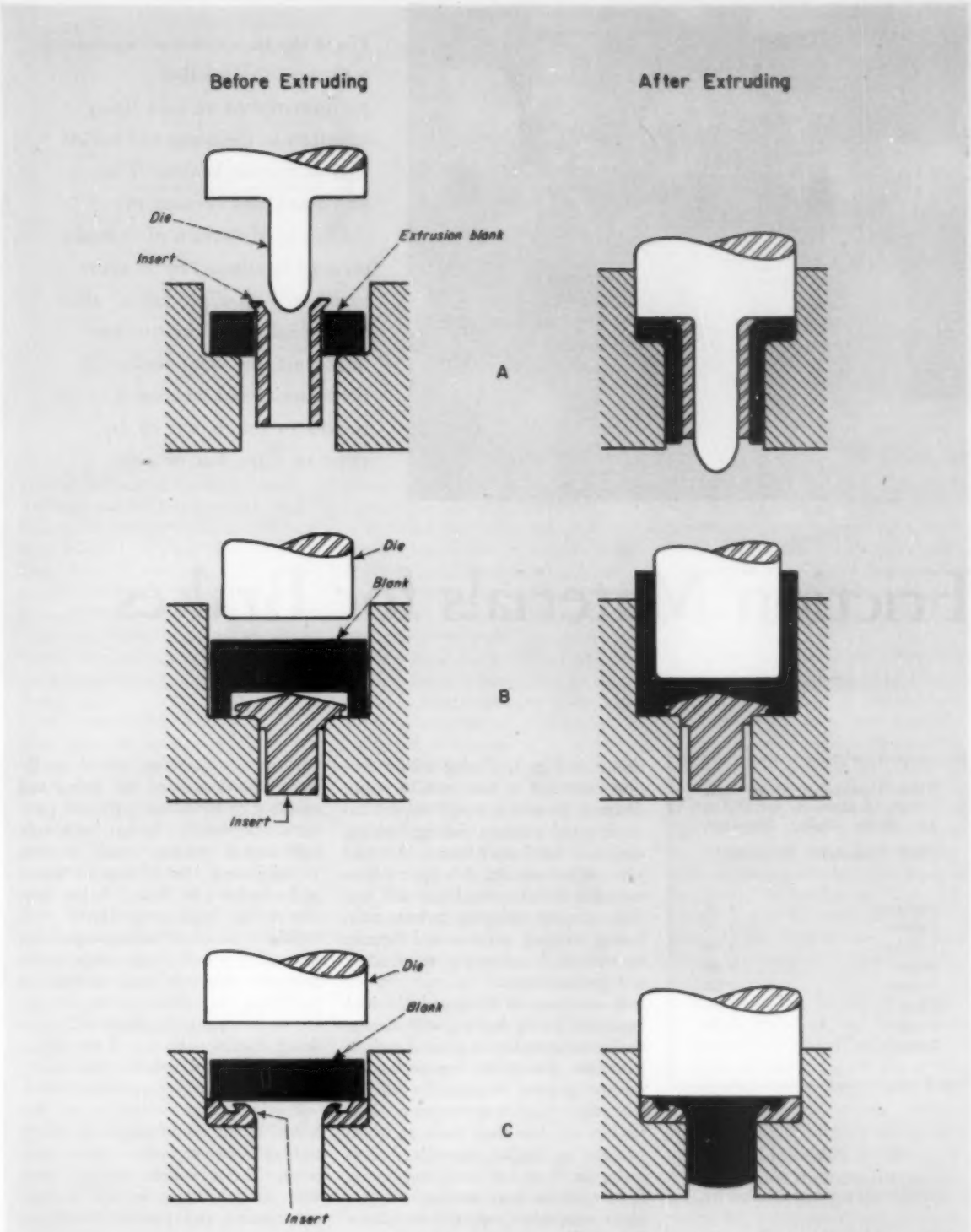
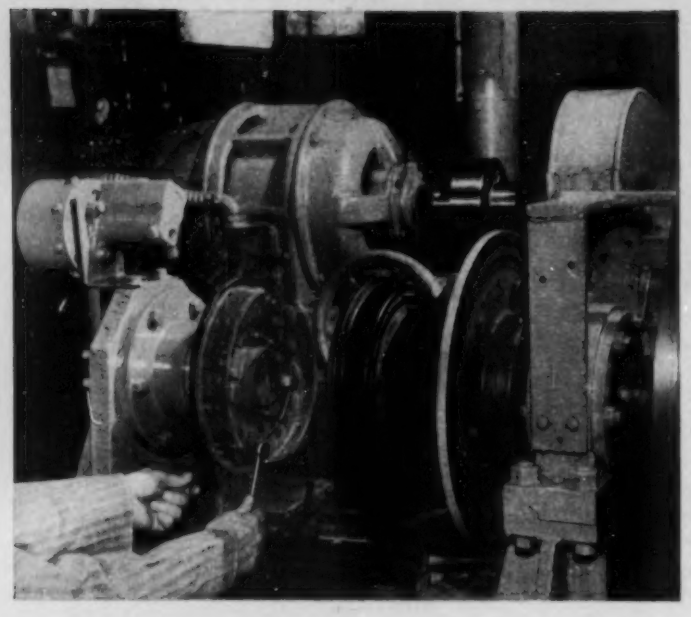


Fig. 8—Three types of steel inserts for aluminum extrusions.



There can be no mutual agreement regarding the relative performance of various lining materials in the many and varied uses of friction brakes. This problem arises because the coefficient of friction of a brake material is affected by so many variables. Principle among these are the nature of the surfaces in contact, the composition of the material and whether it is smooth or rough, wet or dry, clean or dirty, hot or cold.

Friction Materials for Brakes

Table I—Average Mohr Scale Values of Hardness for Different Brake Lining Materials.

(Ref: Diamond = 10, talc = 1)

Asbestos	3.25
Calcite	3.25
Barytes	3.00
Brass	3.00
Carbon	2.50
Clay	2.50
Copper	2.00
Lead	1.50

W. J. NANFELDT

General Manager, World Bestos Division
Firestone Tire & Rubber Company, Inc.

A thorough understanding of friction materials and their behavior under varying conditions is necessary to insure that a brake lining will meet the demands of a given application.

Brake linings function with sliding friction in the range from 0.25 at the low end to 0.45 at the high end as shown in Fig. 1. Lining with a friction coefficient as low as 0.20 is undesirable because it would require too much pedal pressure during braking, while one rated more than 0.50 would wear out too quickly. A happy medium must therefore be found that will provide adequate stopping power, satisfactory wearing qualities and capacity to withstand temporary overheating and general abuse.

If not properly dissipated, the heat generated during braking will damage the brake assembly in general and, in particular, destroy the organic binders present in most non-metallic linings. Since the critical temperatures of these binders are less than those at which asbestos or similar materials disintegrate, the essence of designing linings is to combine heat resistant asbestos fibers with other materials to achieve the overall properties mentioned above.

In high-friction linings, particles with sharp, jagged edges are added to the basic asbestos structure to raise the coefficient of friction, Fig. 2. Working alone in the asbestos matrix, these particles tend to fracture, thereby accelerating lining wear. Cube-shaped particles are therefore added to increase the density of the lining and enable it to withstand high unit pressures. Conversely, linings with only cube-shaped particles and asbestos would have a low friction coefficient and a tendency to "fade," ie, lose friction at high brake temperatures.

Some types of carbon metal particles are malleable and change shape under pressure. Added in small amounts to the lining, they deform when the lining works against the drum and, in so doing, reinforce the face of the lining. Like cube-shaped particles, these malleable particles have a polishing effect.

Friction ranges in linings are stabilized by the use of organic additives such as rubber or cashew nut oil particles. These resilient materials provide the lubrication needed at high temperatures and prevent the lining from becoming brittle.

Controlling "Fade"

High quality brake linings will recover from "fade" upon cooling, whereas lower grade linings are apt to "glaze" at high brake temperatures,

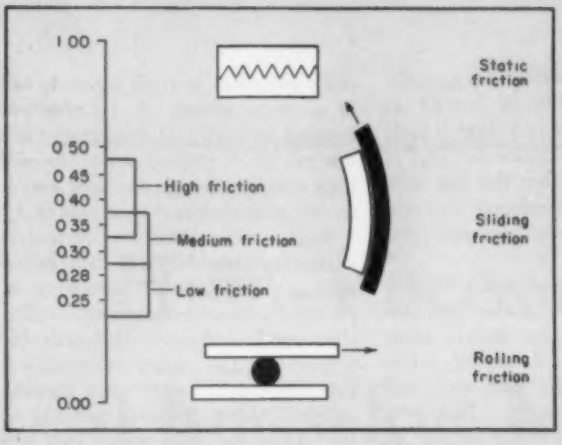


Fig. 1—Range of coefficients for sliding friction shows that values of about 0.25 and 0.45 are limits for practical usage.

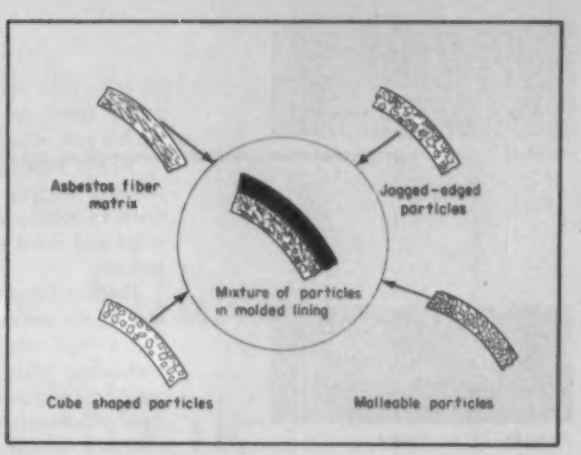


Fig. 2—Brake lining molded from asbestos matrix and one or more particle additives. Choice of latter depend on application.

causing permanent loss of friction.

Lining manufacturers control "fade" with brass particles. These are carefully selected for size and constitute from 8 to 12 percent of the lining weight. When the lining temperature exceeds 600 F, the brass particles become hotter than the face of the lining and form a copper oxide that inhibits excessive polishing on the face of the lining.

As brake lining is subjected to a wide range of pressures while in use, all components of the lining must be softer than the drum to prevent scoring. Hardness of the lining particles should not exceed a Mohs scratch test value of 3.4 because a good cast alloy brake drum will have a comparable value of 3.5 to 3.75. An exceptionally good drum will have a hardness of 4.0, while a poor one will be in the 3.0 to 3.25 range. Table I lists the hardness values of different materials.

Ideal Lining

The ideal brake lining would be characterized by a uniform or constant braking action under a variety of operating conditions. It would have a fixed coefficient of friction at both high and low temperatures, either wet or dry, and this value would remain the same for the life of the lining. Accordingly, a lining conforming to these specifications would have a coefficient of friction of about 0.45. Wear would not exceed 0.001 in. for each 1,000 brake applications when stopping a vehicle from 50 mph once per mile at a deceleration rate of 16 ft/sec/sec. And, these conditions would remain essentially constant at all temperatures up to 700 Fahrenheit.

Such a lining does not exist. Although manufacturers are constantly working toward this ideal goal, present-day linings slowly disintegrate at the friction face under the high temperatures developed while converting the energy of motion into heat. This disintegration is attributable to chemical and physical changes which cause either an increase or decrease in the coefficient of friction.

Even the best of linings are sensitive to water. The result is "morning sickness" which is caused by dust on the face of the lining and iron oxide on the brake drum. These conditions produce a high friction reaction for the first few stops after the vehicle has been standing overnight in a damp atmosphere.

As for life expectancy of modern linings, they are designed to wear at a slow, even rate. This results in consistent braking action with the friction surface being removed continually. If there is no noticeable wear, the result may be a "glazed" friction surface which is subject to "fade."

Types of Lining

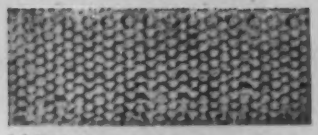
Woven asbestos lining, Fig. 3(a), is composed of a strip woven from long asbestos fiber yarn reinforced with brass or zinc wire. The latter is treated with various compounding materials, such as linseed oil, chinawood oil, natural and synthetic resins, asphaltic or bituminous materials; then cured by baking, and finally formed by compression to correct sizes.

Probably the biggest drawback to this type of lining is its high cost. To weave properly the long asbestos fibers, they must be fiberized, mixed with cotton fiber, carded and spun into yarn. These long fibers cost about $550.00 per ton, while short fibers bring $68.50 per ton.

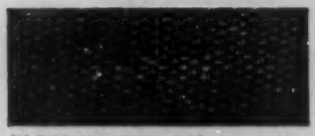
Folded and compressed lining, Fig. 3(b), also incorporates long asbestos fiber yarn as a base. It is constructed by weaving the yarn into cloth, impregnating with waterproof materials, calendering, frictioning both sides with a rubber compound to fill the openings of the weave, cutting into strips, folding the strip upon itself and curing in a cavity mold under heat and pressure. A lining of this type tends to delaminate in service at high temperatures; and the long asbestos fibers increase costs appreciably. This type lining has been used widely on logging winches.

Molded-woven lining, Fig. 3(c), has each strand of the yarn coated with a rubber-based compound. It is solid woven and each ply is held together by binder threads with molding compound filling the openings between the yarns during the pressing and heating operations. High cost is again a restricting factor.

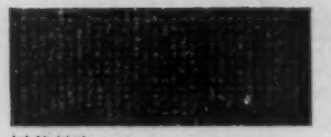
The hot sheeter type of lining was one of the first molded types that eliminated woven asbestos and permitted the lining to be made either flexible or rigid in segments or rolls. Fabrication involves mixing long and medium length asbestos fibers with natural or synthetic rubber, pigments and solvents. The soft stock is then fed between two rotating rolls, one hot and



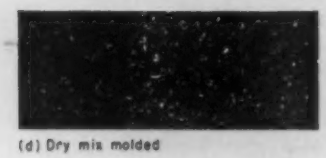
(a) Woven



(b) Folded and compressed



(c) Molded woven



(d) Dry mix molded

(e) Extruded molded

(f) Wireback molded showing wire grid

Fig. 3—Each brake material has its own distinctive appearance.

the other cold, and a thin film approximately 0.002 in. thick is formed on the hot roll. Gradually a sheet is built up to the required thickness. This is cut and stripped from the hot roll, dried to remove all solvents, cut into strips and cured under heat and pressure.

The laminated construction contributes to the strength of this type lining. A high quality hot sheeter lining containing brass and phenol resins exhibits exceptionally long wear and good frictional stability. This is a relatively expensive lining because of the large quantity of long fibers necessary to its construction. Lining of this type is used extensively on hydraulic brakes for passenger cars and light trucks.

Millboard type molded linings are manufactured by the wet process. This is one of the older methods devised for turning out friction materials with short asbestos fiber felted into laminated sheets. When completely dried, the sheet is cut into oversize segments and immersed in an impregnating solution of drying oils, thermosetting resins, a solvent and bituminous materials. After complete saturation, the linings are cured in a series of baking operations to harden the bonding materials.

While this process permits the use of low-cost, short asbestos fiber, the fact that the major part of the bonding materials must be impregnated into the lining, limits this lining to special applications on small size brakes for passenger cars and industrial uses.

Dry mix molded linings, Fig. 3(d), are manufactured from dry ingredients by a simple process made possible through the development of low-cost, thermosetting powdered phenol resins. Short and medium length asbestos fibers are mixed with the resins and other dry ingredients. A predetermined quantity of the loose, mixed material is then compressed to a density that will permit handling and curing of the resulting slab in a hot plunger-type mold. Dry mix brake linings are the most heat stable now in general use. Brake blocks for service on tractors, trailers and coaches are typical applications.

Extruded type molded linings, Fig. 3(e), have gained wide acceptance for passenger cars in recent years because of their low-cost and consistent uniformity. Linings of this type are generally furnished in rigid segments and in a wide variety of compositions ranging in frictional properties from low to high. Combinations of low and high friction linings are used extensively on duo-service type brakes.

Short asbestos fibers are fiberized in a rotating shredder and then mixed with a liquid binder consisting of phenol-cresol thermosetting resins, chinawood oil, linseed oil, rubber and a solvent. The mixed compound is extruded through a die as a continuous trip. After drying to partially set the resins, the strip is cut into prescribed lengths and heat cured in curved molds. By this process, a wide variety of wear-resistant friction modifiers can be added to the base formulation during the mixing operation.

Wire-back molded linings, Fig. 3(f) are the most popular on the market today. This lining is reinforced with a woven wire grid backing, which makes it possible to manufacture flexible linings from low-cost, short asbestos fibers in the low to high friction range. Under severe braking operations, the grid adds to the structural strength of the flexible lining by providing greater resistance to the shearing action of the rivets.

This type lining is formed into strip by a calendering process in which granular particles of the mixed compound are compressed and embedded in the wire-backing while passing between male and female rolls. After drying, the strip is cured according to a closely controlled baking schedule. The liquid binders commonly used are processed linseed oil, thermosetting resins and natural or synthetic rubber. Sulfur is added to the base compound for curing the rubber and linseed oil.

The chief advantage of flexible wire-back lining is that unlike many other types, it readily seats itself to a slightly worn brake drum and is exceptionally quiet in service.

No matter what method of manufacture, all of the linings discussed above have three things in common: each consists of minerals, metals and organic materials. Their rate of wear, frictional qualities and resistance to "fade" depend upon the kind and quality of each ingredient used in their fabrication. The all-important factor of cost has to be weighted against desired performance; thereby making it necessary to engineer each lining for a specific use.

High-Viscosity Silicone Fluids for Mechanical Applications . . .

Torsional Vibration Dampers
Fluid Couplings
Servo and Gyro Dampers
Dash Pot Dampers
Fluid Springs

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Silicone Products Department
General Electric Company

Silicone fluids with viscosities in the range of 1,000 to 100,000 centistokes offer important advantages over organic fluids as well as over lower viscosity silicones in many applications. These advantages stem from the fact that the high viscosity fluids combine many of the desirable properties of low viscosity types such as inertness, heat and electrical resistance with improved temperature-viscosity characteristics, greater stability, and higher resistance to shearing forces.

NEW GRADES OF SILICONE FLUIDS with viscosities many times higher than those of types already in widespread use are finding increasing applications and are extending the range of usefulness of silicone materials.

These fluids reduce sealing and gasketing problems and permit the use of larger clearances in products such as dampers, as well as stamped, punched and cast components in place of close-tolerance machined parts.

Inertness and stability at elevated temperatures combined with low surface tension add advantages for parting agents to promote release of contacting surfaces. Reduced effect of shear rate and temperature on viscosity gives improved performance and lower cost in mechanical and hydraulic applications. High compressibility and stability at elevated temperatures and pressures make possible fluid springs with more capacity in a given space.

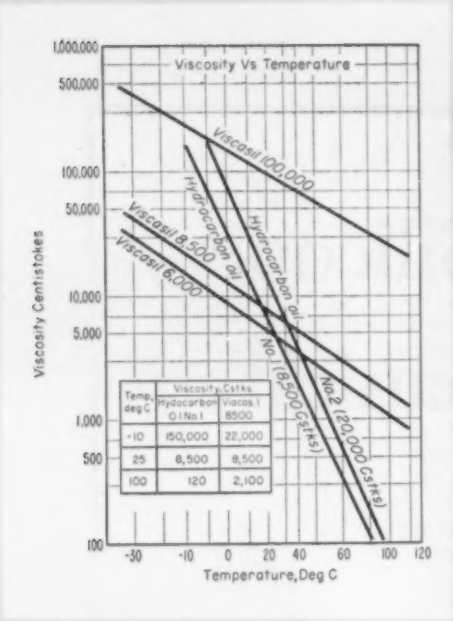


Fig. 1—Viscosity-temperature characteristics of three high viscosity silicone fluids compared with two hydrocarbon oils of the same viscosity range.

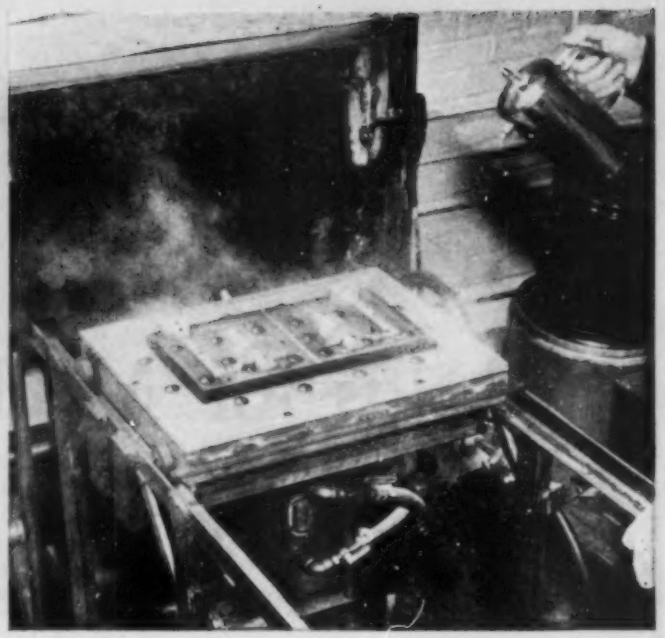


Fig. 2—High viscosity silicone fluid being sprayed on a shell mold acts as an effective parting agent. Similar release applications arise in the die casting of zinc and aluminum alloys.

VISCOSITY-TEMPERATURE CHARACTERISTICS—In mechanical applications, viscosity-temperature characteristics are of prime importance. All fluids show some change in viscosity with temperature but silicone fluids have a smaller change over a wide temperature range than any other known fluids.

Viscosity-temperature curves for a group of methyl-type high viscosity silicones, the Viscasil fluids developed by General Electric, are shown in Fig. 1. Similar curves for two hydrocarbon oils that fall within the same viscosity range are included for comparison. The table inserted in this figure shows the viscosities, at 100 C and —10 C, of a high grade hydrocarbon oil and a Viscasil fluid, both of which have equal viscosities at room temperature.

General data on the properties and characteristics of Viscasil fluids for mechanical and hydraulic applications are given in Table II; typical physical properties are listed in Table I. Since solidification temperatures are difficult to determine, a solidification range is reported in the latter. This varies from —50 to —60 C, and, what is equally important, high viscosity silicones remain fluid almost to solidification. Thus, they can be used at temperatures as low as —50 C.

Table I—Typical Properties of Viscasil Silicone Fluids

(Minimum Flash Point — 315C or 600F)
(Weight — 8.1 lb/gal @ 25C)

Viscosity at 25C		Specific Gravity 25C	Solidification Range Deg. C	Viscosity Temperature Coefficient (Approx.)
Centistokes	SSU			
5,000	24,000	0.96	−56 to −60	0.61
10,000	48,000	0.97	−53 to −57	0.61
30,000	143,000	0.97	−50 to −55	0.61
60,000	286,000	0.97	−50 to −55	0.61
100,000	480,000	0.97	−50 to −54	0.61

RELEASE APPLICATIONS—Because of the aforesaid properties, and their low surface tension (about 21 dynes/cm compared with about 35-40 dynes/cm for similar organic oils), high viscosity silicones readily form a continuous film, making them an effective parting agent. The most noteworthy use is in the shell molding process, Fig. 2. In this, and other molding applications, inertness combined with freedom from decomposition or carbonization at elevated temperatures results in better release, reduced maintenance costs, longer mold life and fewer rejects.

Adhesion of ice to such items as aircraft wings and propellors, flexible hose, electrical cables, and other parts which will be bent, shaken, or flexed in any way can be materially reduced by coating the surface with silicones of 40,000 to 100,000 centistokes.

Other release type applications for which high viscosity fluids have proved to be better than the lower viscosity types include: die casting of zinc or aluminum alloys, impregnation of gaskets to prevent sticking and as anti-blocking additives or surface treatments for wax or for plastic films.

Table II—Characteristics, Mechanical and Electrical Properties of Viscasil Silicone Fluids

HEAT RESISTANCE

Remain free from discoloration, acid formation, sludging, oxidation and similar phenomena which limit the usefulness of organic fluids, for thousands of hours at temperatures as high as 150 C (302 F). In closed systems they are stable at temperatures as high as 200 C (392 F).

Flash points are above 600 F, considerably higher than those of comparable petroleum oils. In addition, Viscasil fluids will not support combustion unless external heat is supplied to hold the temperature over 600 F. This makes them particularly attractive for damping and hydraulic applications.

COMPRESSIBILITY

Silicone fluids are considerably more compressible than petroleum oils and most organic liquids. Viscasil 1000 centistoke fluid shows a 15 percent decrease in volume under a pressure of 50,000 psi and a 30 percent decrease in volume under a pressure of 350,000 psi. Higher viscosity Viscasil fluids are slightly less compressible.

The percent compressibility of several silicone fluids and of several straight chain hydrocarbons at four different pressures has been determined and typical data are shown in Table IV. In these tests, all of the hydrocarbon fluids froze at relatively low pressures, all of the straight chain dimethyl silicones remained fluid even at the highest pressure applied.

INERTNESS

Not corrosive to common metals and are generally unaffected by them at temperatures up to 200 C (392 F) even in the presence of oxygen. Good resistance to aqueous solutions containing less than 30 percent of inorganic acids and bases. Have no effect on plastics or organic coatings but may cause a slight decrease in the weight and volume of certain rubbers immersed in them for prolonged periods at elevated temperature

They are insoluble in and will not react with water. Equivalent in water repellency to the best organic materials.

ELECTRICAL PROPERTIES

Possess the same excellent electrical properties over a wide range of frequencies and temperatures as the lower viscosity silicone fluids. Dielectric constants of these fluids are practically constant up to frequencies as high as 3000 Mc and vary only from about 2.7 to 2.2 between 25 and 200 C. Power factors vary from about 0.003% to 0.002% over the same range. Sixty cycle dielectric strength is 35 to 40 kv across a 0.10 in. gap in an ASTM test cell.

SHEAR STABILITY—Because of the great interest in the use of silicones in mechanical and particularly in damping applications, a considerable amount of data on their flow and shear characteristics has been obtained.

Low molecular weight, and hence low viscosity, silicone fluids are essentially Newtonian in behavior, that is, the measured viscosity does not change with different rates of shear. Fluids like General Electric's SF-96 series, which covers the range 40 to 1,000 centistokes, are typical examples of this category.

Those having viscosities above 1,000 centistokes, exhibit pseudoplastic flow. There is deviation from linearity when the apparent viscosity is plotted against the rate of shear. Furthermore, as the absolute viscosity and molecular weight are increased, the deviation becomes more pronounced.

High viscosity silicones show a much smaller loss in apparent viscosity at high shear rates than organic fluids. Also, the loss in apparent viscosity described above is a transitory condition; the fluids will return to their original absolute viscosity on cessation of shear.

Typical curves showing the ratio of apparent viscosity to viscosity at zero shear rate plotted against rate of shear are shown in Fig. 3. Experience has shown that exposure to shear for long periods of time has little effect on the absolute viscosity of high or low viscosity fluids. Tests on low viscosity silicones (References 1 and 7) showed that after as many as 150,000 cycles at pressures up to 2,000 psi, the viscosity change was about 2 percent. Under the same conditions the viscosity change of petroleum fluid AN-VVO-366A was more than 30 percent and that of petroleum oil OS 2943 was more than 50 percent. The high viscosity fluids have a similar resistance to breakdown at high shear rates.

DAMPING APPLICATIONS—The combination of small change in viscosity with temperature, outstanding high temperature stability, low pour points, and excellent shear characteristics has led to the use of high viscosity silicones in numerous damping and hydraulic applications. They make possible the use of wider clearances and simplified design. In addition, they have improved performance charac-

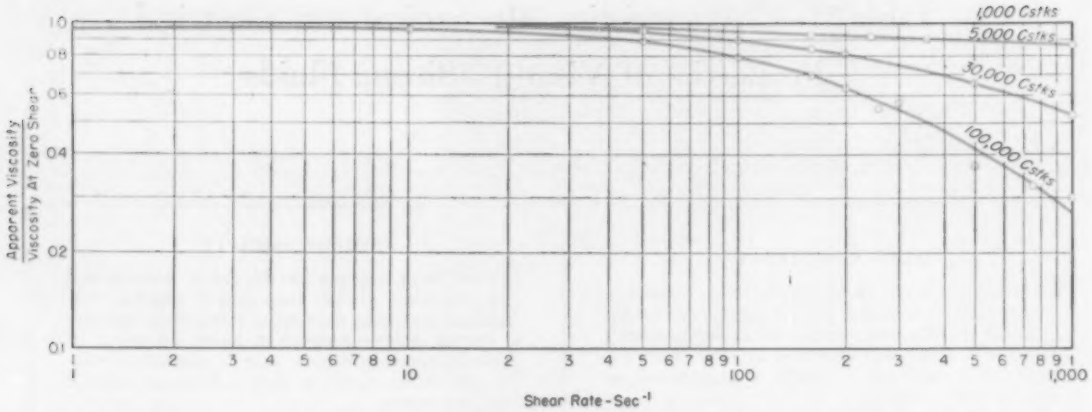


Fig. 3—Typical curves for ratio of apparent viscosity to viscosity at zero shear rate vs shear rate for Viscasil silicone fluids. These desirable shear characteristics make high viscosity silicone fluids useful in damping and other mechanical applications.

teristics, greater reliability, and longer life.

In many cases the design of these silicone-filled units has been simplified to the point where the unit costs less, or at least no more, than the more complex and less satisfactory unit that it replaces.

One of the most promising fields of application for fluids like the Viscosil type is in viscous damping or power transmitting devices in which the damping action or transmission of torque is obtained by means of the shear strain of the fluid.

When two surfaces are separated by a film of viscous fluid, the force necessary to move one surface with respect to the other is directly proportional to the area of the smaller surface, the relative velocity of the two surfaces, and the absolute viscosity of the fluid, and is inversely proportional to the thickness of the fluid film.

The control of surface areas and the distance between them presents no problem. The problem, therefore, is in maintaining a relatively constant value of the absolute viscosity, and hence a constant damping force, over the operating temperature range.

Because the viscosities of organic fluids decrease at a rapid rate with increase in temperature, and also because their absolute viscosities decrease at a rapid rate with increase in the rate of shear, their usefulness in applications of this type is extremely limited. As a result, although viscous

Table III—Comparison of Damping Characteristics

	Pounds of Damping Force	
	−40C (−40F)	70C (160F)
Dimethyl silicone 30,000 cstks.	210	70
Petroleum oil (very high viscosity)	70	0.028

The damping force decreases in the ratio of only 3 to 1 for the high viscosity fluid while that of the petroleum oil decreases in the ratio of 2500 to 1 over this temperature range.

Table IV—Percent Compressibility of Silicone Fluids

	7,100 psi	35,500 psi	284,000 psi	568,000 psi
SF-96 (100)	4.5	12.7	28.6	34.0
Viscasil 1000	4.6	12.7	28.2	33.5
Viscasil 12,500	4.5	12.5	28.1	33.5
n-Heptane (0.57 cs)	5.0	14.3	Freezes	
n-Dodecane (1.82 cs)	3.5	Freezes		
n-Hexadecane (4.01 cs)	Freezes			

Fig. 4—Viscous torsional damper has space between housing and flywheel ring filled with a high viscosity silicone fluid. Attached to the crankshaft of trucks, tractors and other vehicles, these units dampen excessive vibrations of the crankshaft at high-speeds.

damping or torque device containing organic fluids were often proposed, their application was limited.

High viscosity silicones, on the other hand, are ideally suited for use in these applications because of improved viscosity temperature characteristics and excellent shear stability. Table III compares data for the change of damping force of a high viscosity silicone fluid with that of a high viscosity petroleum hydraulic oil.

Viscous Torsional Vibration Dampers

The viscous torsional vibration damper, Fig. 4, consists of a light weight housing which encloses an annular space containing a loosely fitting ring that functions as an inertia mass or flywheel. The clearance between the flywheel ring and the housing is filled with viscous silicone fluid. The housing is rigidly attached to the crankshaft whose vibrations are to be damped and, in operation, drags the flywheel ring around with it through viscous action.

Because of the high viscosity of the fluid, the inner flywheel or inertia mass rotates uniformly at engine speed. When critical speeds that cause torsional vibration are reached, however, the flywheel tends to continue to rotate at a constant speed. Hence, the torsional vibrations are damped by the drag of the viscous film between the casing and the inner flywheel.

This type of damper is being used on internal combustion engines ranging in size from automotive engines to locomotive diesels. It does not require tuning to a particular engine and damps both major and minor critical orders of vibration.

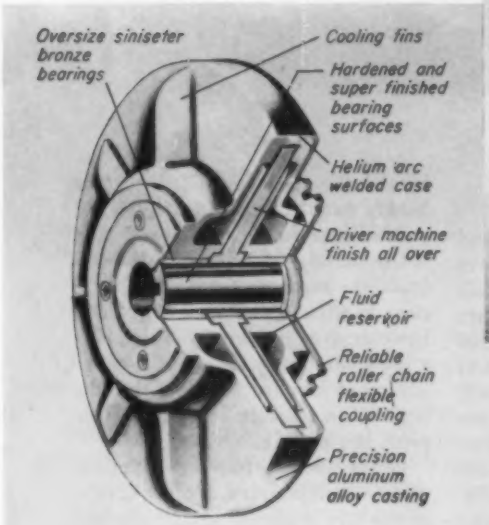
Fluid Couplings

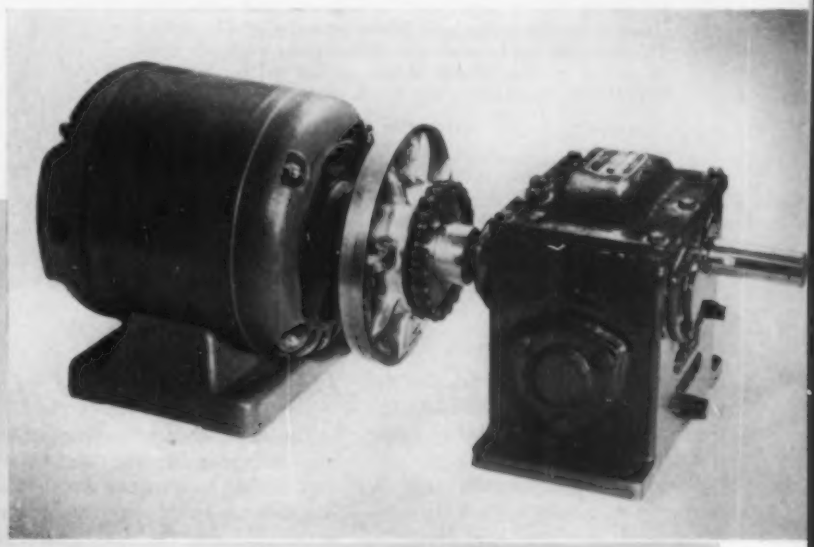
The "Sterner" fluid coupling, Fig. 5, manufactured by L & S Industries of Norwalk, California, illustrates a device which uses the viscosity stability, small change in apparent viscosity with changes in shear rate, and resistance to shear breakdown of high viscosity silicone fluids.

This coupling transmits torque from a driving disk to a pair of driven faces by means of the shear strain of the fluid. It can be used for conveyors, crane drives, mixers, punch presses, and similar heavy duty equipment.

Servo System and Gyro Damping

Viscous damping has been widely adapted to servo systems and its use in such applications has been discussed by Kaplan (Ref. 6). In one type of installation a flywheel of inertia much larger than the servo motor is bearing-mounted on the rotor shaft. A low inertia disk is rigidly connected to


Oversize siniseter bronze bearings
Cooling fins
Hardened and super finished bearing surfaces
Helium arc welded case
Driver machine finish all over
Fluid reservoir
Reliable roller chain flexible coupling
Precision aluminum alloy casting



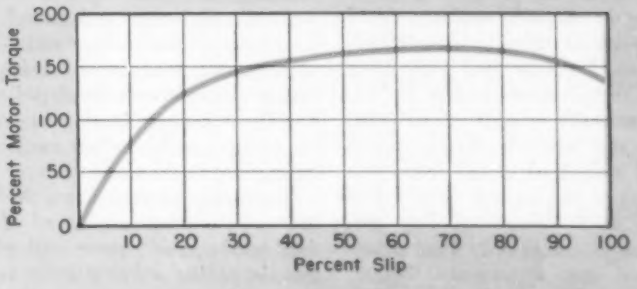


Fig. 5—Typical construction and application (upper right) of fluid coupling that transmits torque by means of shear strain of a high viscosity silicone. Coupling is self lubricated and provides smooth acceleration of inertia loads. Typical torque-slip curve for a 1,750 rpm motor (right).

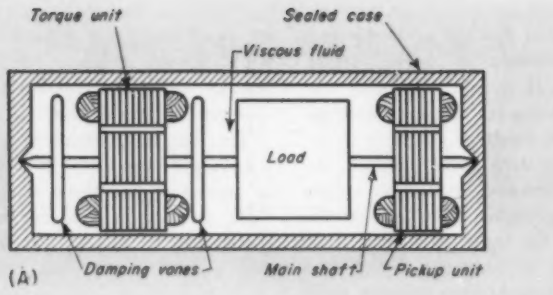


Fig. 6

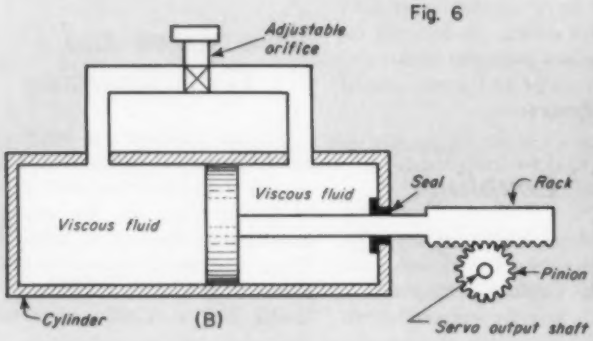


Fig. 6—(A) Sealed assembly consisting of an input torque unit and an output pickup that is used in certain types of computers. Immersing disk of output shaft in a viscous fluid, a drag proportional to velocity is obtained. However, sealing can be a problem. This objection can be overcome when angular motion is restricted by design in (B). Piston motion is damped by forcing fluid through the adjustable orifice. Good for low speed; high torque.

Fig. 7

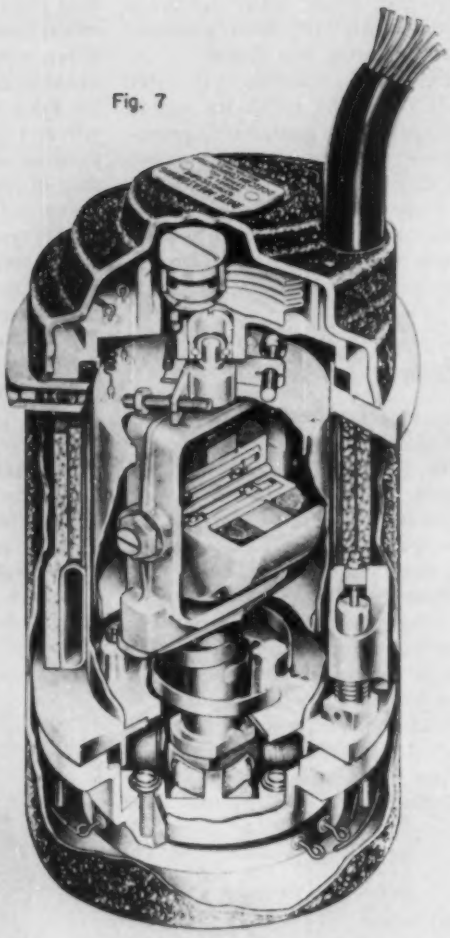


Fig. 7—Rate measuring gyroscope manufactured by the Doelcam Corporation of Boston, Mass. All of the body of the instrument within the outer case and around the hermetically sealed gyro motor is filled with high viscosity silicone fluid. This provides controlled viscous damping over the range —67 to +85 F.

the rotor shaft adjacent to the flywheel. Coupling between the disk and the flywheel is then provided by a thin film of viscous silicone.

For a constant velocity motion of the servo, there is no relative motion between the flywheel and disk. However, when the system either accelerates or decelerates the flywheel tends to continue to rotate at constant speed and hunting or creeping is controlled.

A second system used with servo mechanisms, is shown in Fig. 6. This sealed assembly consists of an input torque unit and an output pickup coupled to the load. A disk on the output shaft of the servo is immersed in silicone fluid and viscous drag proportional to the velocity is obtained.

Typical gyro applications, Fig. 7, are in guided missile control systems.

Dash Pot Dampers

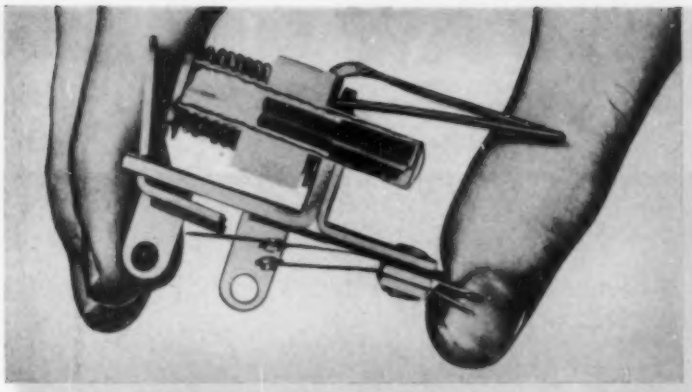
The small change in viscosity and small change in damping characteristics over a wide temperature range which is exhibited by viscous silicones are responsible for the development of many dash pots, time delay relays and similar devices used to protect motors, electronic equipment and control systems from overload. They assure consistent operation of one of the simplest timing elements ever developed, Fig. 8. There are no heating elements, no gaskets, no levers, no mechanical connections to the armature.

The timing element forms the very heart of the relay and instead of the fixed solid core of conventional relays, this device has a hermetically sealed brass tube extending through and beyond the solenoid coil. The tube holds a movable iron core and is filled with silicone fluid.

On starting inrush or small overloads, the magnetic force is not sufficient to attract the armature. It does, however, draw the core into the field at a rate controlled by the viscosity of the silicone to introduce a precise time delay. When the core reaches the pole piece, the relay is activated.

Organic fluids which were formerly used in dash-pots and in other devices of this type thickened in cold weather, resulting in slower response; they thinned out in warm weather or in high ambients and the device responded too rapidly.

These problems are eliminated by taking advantage of the flat viscosity-temperature curve of the viscous sili-



Heinemann Electric Co., Trenton, N. J.

Fig. 8—Cross-section of a time delay relay that uses a high viscosity silicone fluid as its damping medium. Complete time element is a movable iron core which is held within a hermetically sealed tube filled with silicone. Characteristics depend on core design and liquid properties

Fig. 9—Typical application of Hydra Springs.* Cutaway shows springs used on hole punching unit that is used with materials up to ¼ in. thick. Fluid springs of this type are available with capacities up to 8,000 lb

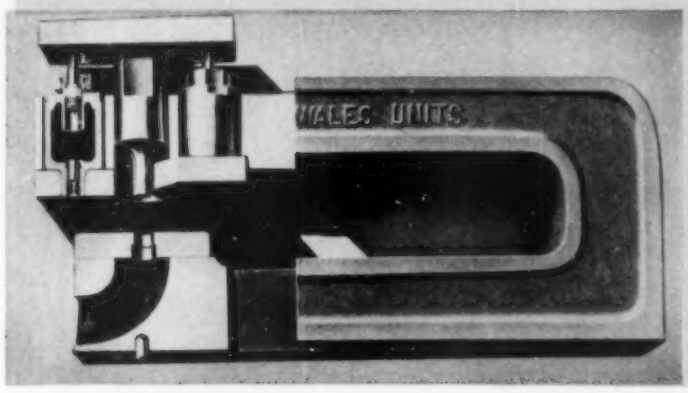


Fig. 10—Tension type of fluid spring for a military application. Eliminates all hydraulic piping, accumulators and valves with a self-contained unit. Provides a 7,000 lb spring equal to a coil spring 18 x 4 in. dia, 1 in. wide.

cones. In addition, since these fluids are available in a wide range of carefully controlled viscosities, variations in time of response may be obtained simply by proper selection of the viscosity of the fluid.

Fluid Springs

The combination of high compressibility, relatively small change of viscosity and compressibility over a wide temperature range, freedom from oxidation or vaporization at elevated temperatures and at high pressures has led to the use of high viscosity grades of silicone fluids as a major ingredient of Wales Comproils which are the basis of the Wales Hydra Springs* manufactured by the Wales-Strippit Corp. of North Tonawanda, N. Y.

These liquid springs utilize the compressibility of this compounded fluid to provide the same resilient action provided by conventional springs. Unlike the fixed loads of mechanical springs, however, the force of these fluid springs may be varied by changing the volume of fluid or the compressibility of the fluid used. Silicone filled fluid springs of this type, Fig. 9, develops up to 600 percent more pressure than conventional springs of equivalent size and may be used in all applications requiring more or varied spring force within a given space.

An unusual tension spring providing 7000 pounds on a 3 in. stroke with a damped return is shown in Fig. 10. This was developed for an installation which required the arresting of heavy objects traveling at high velocity.

Typical of other applications in which fluid springs are finding use are: metal fabricating dies, heavy duty perforating equipment, metal working and machine tool equipment and plastic injection dies.

* *Trademark*

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4. Fitzsimmons, V. G., D. L. Pickett, R. O. Militz, and W. A. Zisman, Trans. ASME, 68, 365, 1936.
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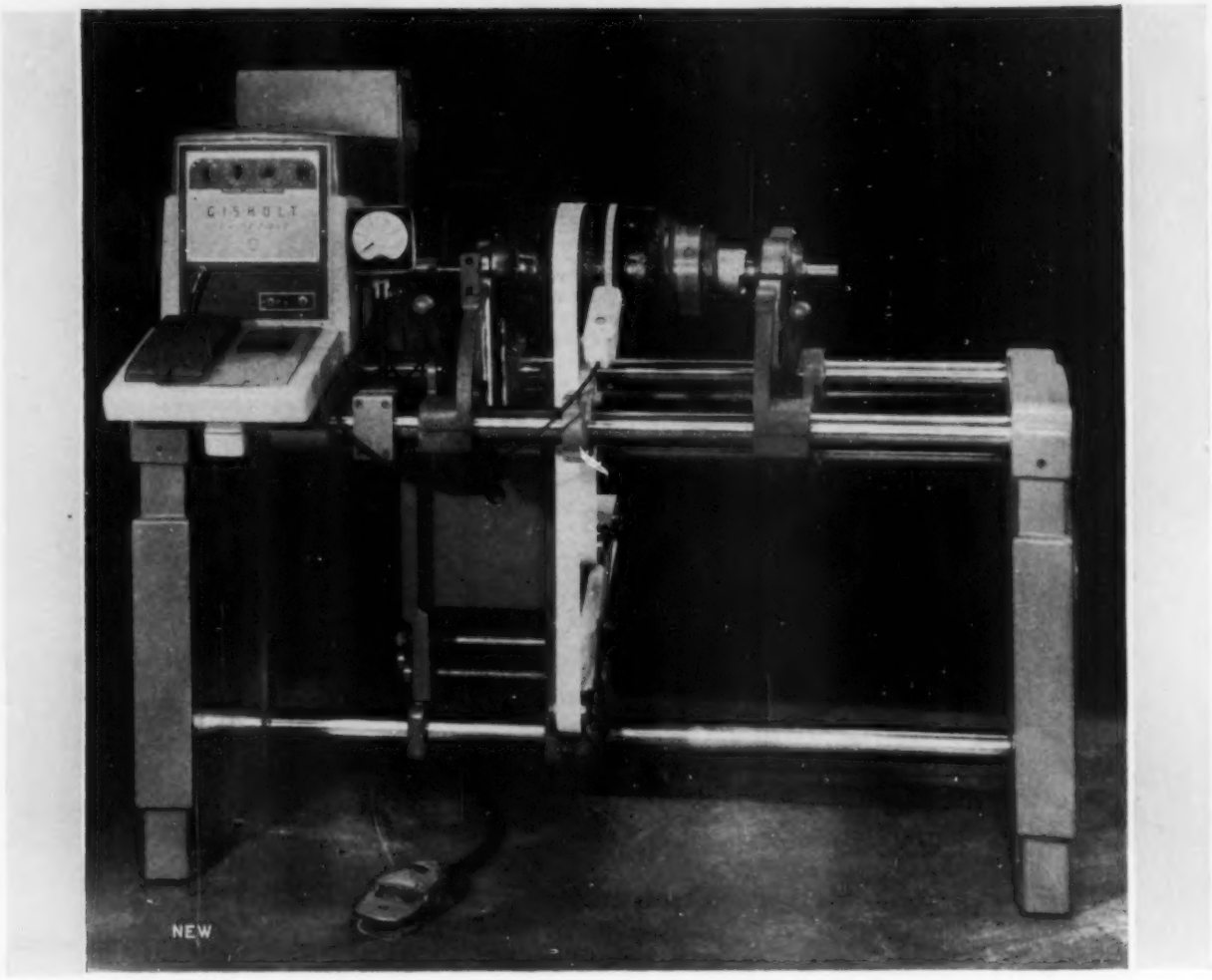
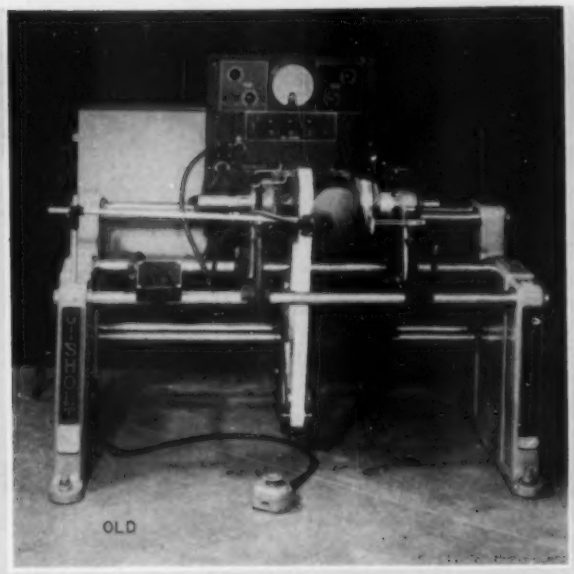
DESIGN FEATURES



Human Engineering Plays Big

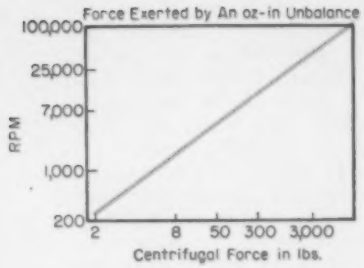
In setting up the objectives upon which to base the redesign of their Dynetric balancing machines, the Gisholt Machine Co., Madison, Wis., placed the principal emphasis on making the operator an integral part of the operation. Rapid development in industry's requirements for balancing machines plus the change in the concept of labor as a production tool gave rise to the stress on human engineering as the pivotal design influence. Significantly, the design philosophy is hinged on playing up the importance and convenience of the operator to assure maximum production based on the design potential.

Also, new concepts in electronic design, arrangement of machine components and functional styling went hand-in-hand with industry's increasing reliance on balancing as an important design criterion. Thus, in the first major redesign of the machine since its introduction in 1935, the changes are not so much centered on improving the method of measuring and locating unbalance, but principally in the components and the arrangement necessary for the most efficient operation.



OLD BALANCING MACHINE (above), developed jointly with Westinghouse Electric Corp., who designed the electronic package, differs from the new design primarily in the stress on operator effectiveness. Technical improvements are largely based on components available then and now.

NEWLY DEVELOPED MACHINE (left) incorporates the same method of measuring the unbalance of rotating parts, but stresses recognition of operator requirements in the type and arrangement of components. Even manufacturer's name registration was evaluated to promote user acceptance.



BALANCING TODAY is taking on a new importance. The average household is using more power driven devices operating at higher rotational speeds than ever before. As a result, minimization of noise and vibration has become a major design problem. How to spell out balancing tolerances in easy-to-understand shop terms is the main facet of this problem. According to Werner I. Senger, Vice-President, Balancing, Gisholt Machine Co., balancing specifications should be on each drawing just as dimensional and material specifications, as heat treatment. Since unbalance is a function of displacement, the modern balancing machine should indicate to the operator the correction required in terms of common items to add or subtract—such items as 1/64 of an inch of length of 0.093 in. dia wire solder, or 0.001 in. of depth of a ¼ in. dia drill. Tolerance is then given as 1/32 of an inch of wire solder, 0.010 in. drill depth.

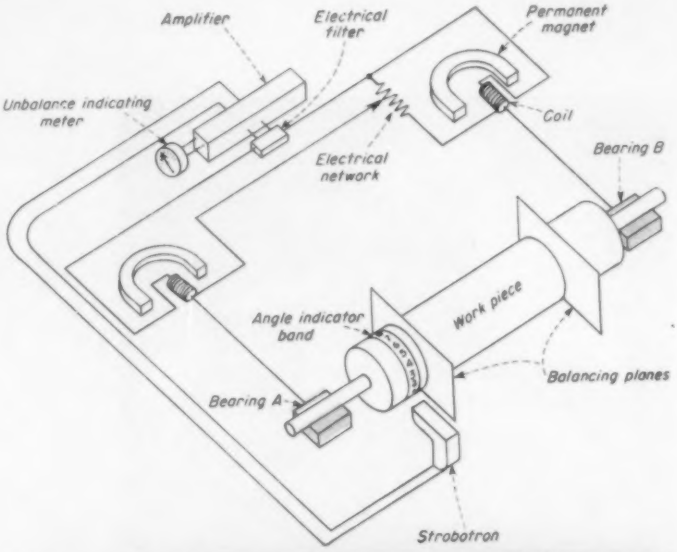
Role in Balancer Redesign

Steady development in electronics pointed the way to the selection of standard components considerably more reliable and less expensive for their specific operation. The number of controls have been reduced and simplified to improve operator effectiveness and convenience. Even such details as redesigning the unbalance indicating meter for adjustable reading positions and for easier needle readings were not overlooked.

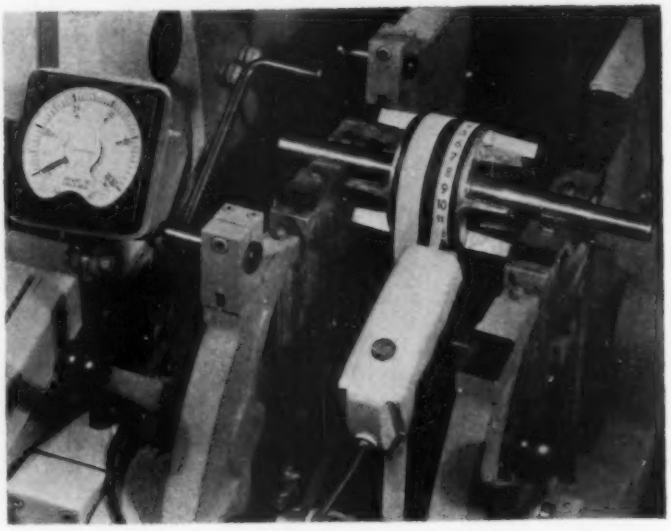
Styling was approached with the thought that convenience and effectiveness could be given a boost if the machine was designed to give the appearance of a laboratory instrument capable of production work. By styling it for clean, eye-appealing lines, operator cleanliness and the intangible work-pride could be promoted which would give impetus to the use of the equipment to the greatest accuracy possible. Serious consideration was even given to the manufacturer's identity, the theory being that if name registration was an integral part of the design, the user would accept it without thought to minimizing its prominence. *(continued on next page)*

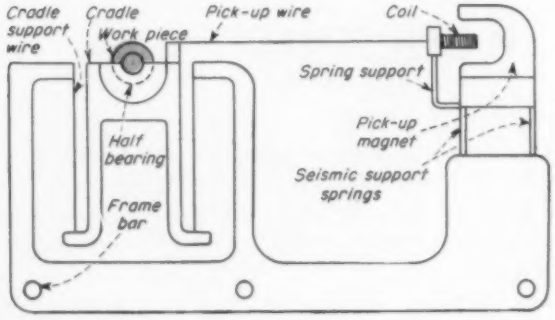
Balancer Redesign (continued)

SCHEMATIC LAYOUT of the correction indicating circuit incorporates an electrical network system to give direct readings of the amount and location of the correction required in each of two selected planes without effect from unbalance in the other plane. Unbalance causes the workpiece to vibrate horizontally about its axis of rotation, the voltage generated in the associated coils being directly proportional to the amplitude of bearing displacement. By using a voltage divider to pick off the voltage generated by the vibration of bearing B which is equal in magnitude to the voltage generated by the motion of bearing A, the effect of unbalance as indicated by the meter can be eliminated. Then by using a similar network system for unbalance in the other plane, a true indication of unbalance in the plane—caused only by unbalance in that plane—is obtained. This unbalance, represented by the voltage addition, is fed through a filter and amplifier to a meter calibrated in correction units.

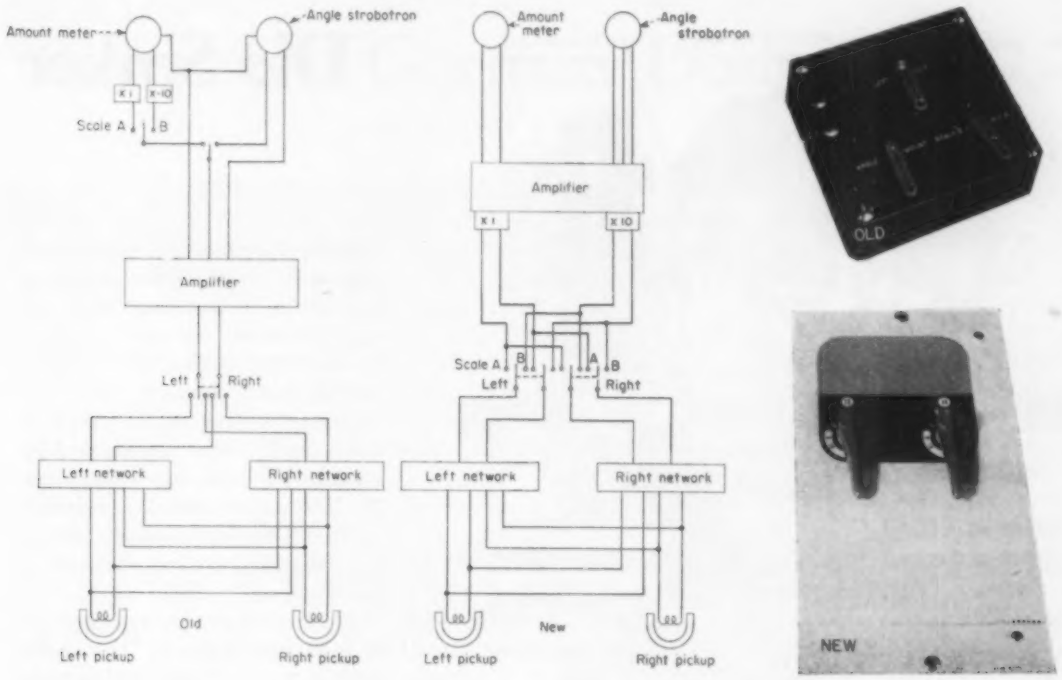


AMPLIFIED OUTPUT discussed above is led into a stroboscopic lamp which flashes as the pick-up voltage changes from positive to negative. A capacitance in the circuit stores the energy which is instantaneously dissipated when, on each revolution of the workpiece, the lamp is electrically triggered. The number on the workpiece which appears to be motionless determines the angular location of the unbalance correction for a particular plane, each of the two networks picking out the unbalance location in its plane.

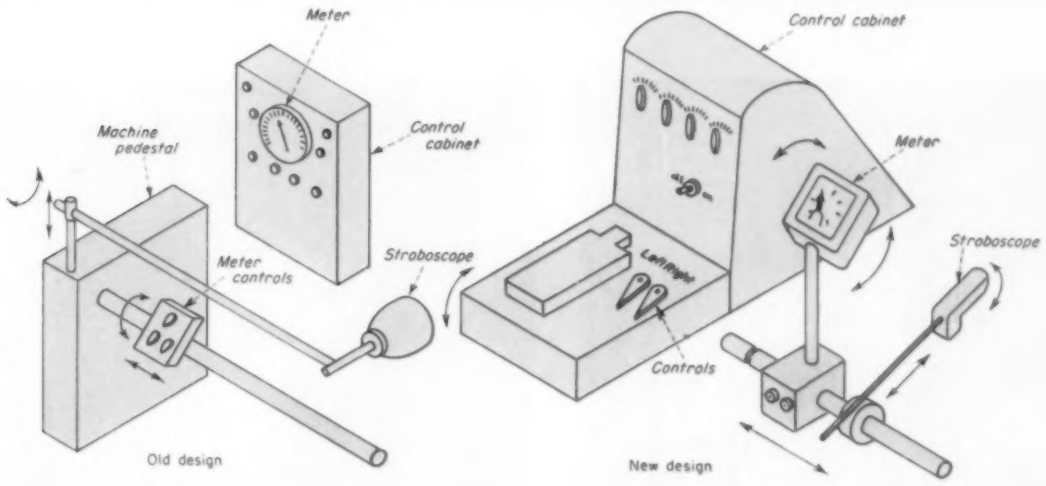




ISOLATION of the workpiece and pick-up device from any vibration other than that caused by unbalance is illustrated in this side sketch. Each end of the workpiece is carried in an aluminum carrier flexibly supported from the frame by wires, the arrangement acting as a seismic mounting which will filter out any floor vibrations whose frequency is greater than 100 per minute. To isolate the pick-up device, consisting of a wire connecting the carrier to a coil in the field of a permanent magnet, the magnet is carried by a structure seismically mounted on the machine base.

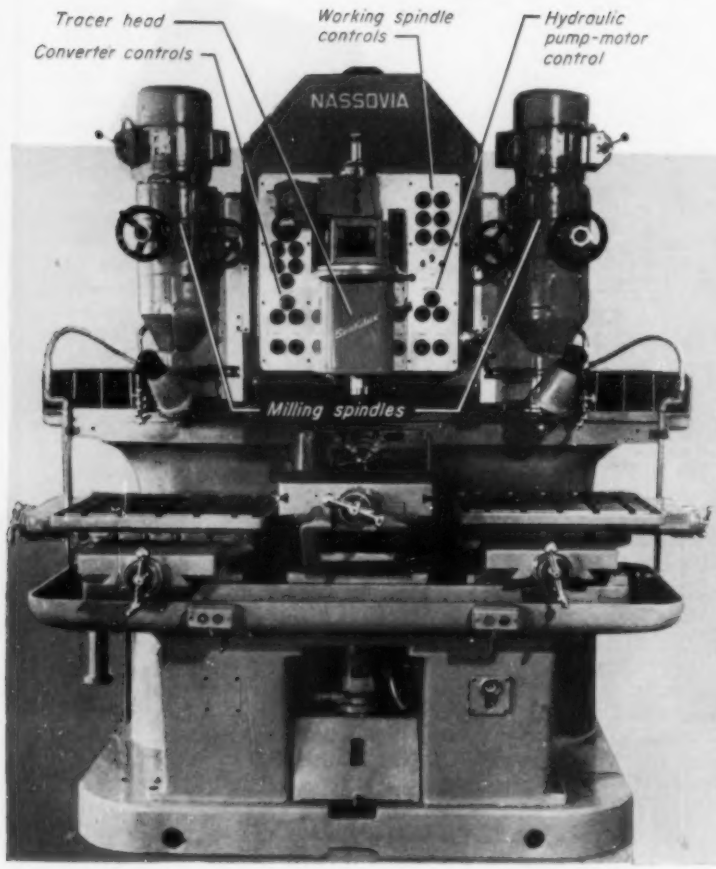


OLD AND NEW switching arrangements point up the simplicity of the new design. Old method used three levers, one for observing the amount and angular location of unbalance, one for "left" and "right" correction plane scales desired. New design consists of only two telephone type switches spring centered in the off position, one switch for "right" plane indication and one switch for "left" plane indication. Each switch uses one direction for both lamp and meter on one scale, other direction for the second scale.



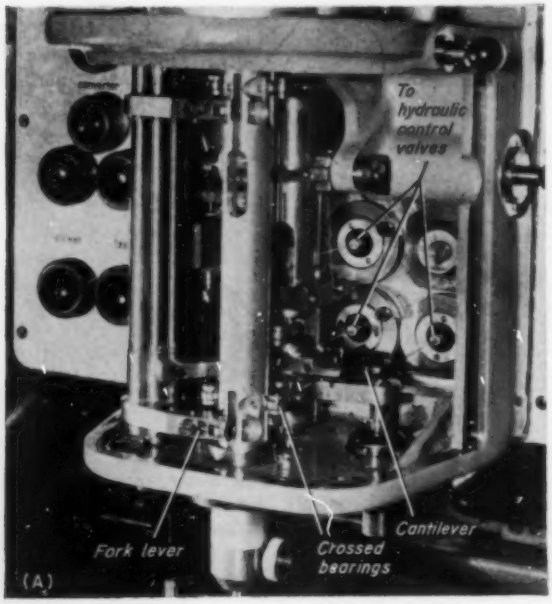
SKETCHES of the arrangement of controls and components illustrates the "operator" approach to the balancing machine redesign. Both designs accomplish the same result, the new model featuring maximum convenience. Note the differences in meter graduation, size of indicating needle, position of meter, number of controls, location of controls, size and position of stroboscope lamp. Arrows indicate adjustability.

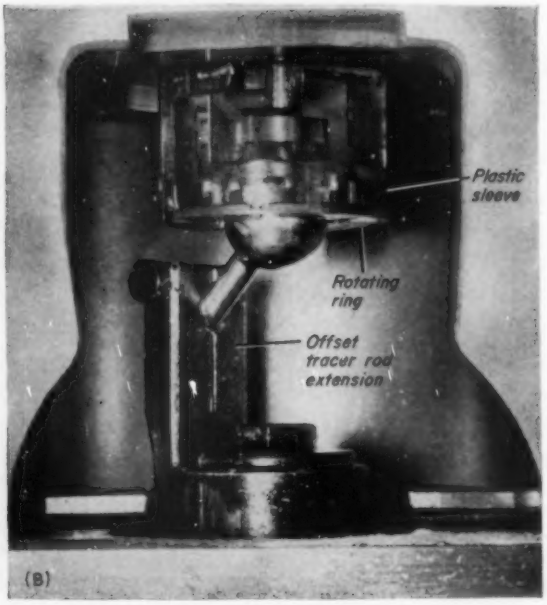
Die Sinker



Some of the latest concepts in German machine tool thinking are given prominence in the design of a new multiple-spindle die sinker machine by Nassovia-Maschinenfabrik, Frankfurt am Main, Germany. Numbered among the features are: 1) Design of the hydraulic tracer element and its associated pre-selection attachment; 2) Use of eccentrically mounted guide rail bearings; and 3) Unusual speed regulation systems for step-less spindle speed control.

The tracing or copying operation is built around the parallel movement of a vertical tracer rod to position the hydraulic control valves which regulate the direction and rate of oil flow to the slide cylinders. Hydraulic system pressure is kept constant and pre-set for the particular





Shows Off German Design

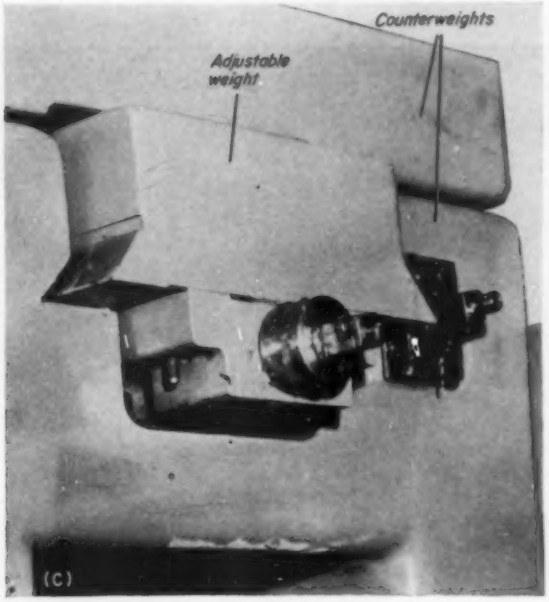
operation. Precise parallelism of the tracer rod is maintained by a system of crossed fork levers, the ends of which contain the rod in an arrangement of pre-loaded ball bearings set at right angles to each other. Thus, by rigidly attaching cantilever arms to the fork levers, movement of the rod is accurately transferred to the cantilevers and their directly coupled hydraulic control valves.

To minimize the inertia effect of moving the large slide weights through rapid direction changes and still maintain a 0.0004 in. accuracy between the tracer rod and milling spindles, the tracer head is equipped with an unusual pre-selection attachment. Consisting of a plastic ring which is rotated at a fixed frequency to give a circular probing motion to the tracer rod, this device assures a continuous compensation for rapid changes in oil flow rates and direction. While constantly maintaining a pre-determined tangent pressure angle between the rod and the master, a new probing action is always underway to detect imminent changes in contour requiring rapid movements of the slides.

A feature of the design which adds to the versatility of the machine is the use of interchangeable milling spindles permitting both normal milling and super-finishing operations. The working spindles operate from 170 to 3400 rpm, speed being controlled by an eccentrically designed ring and cone arrangement. Finishing is achieved with the use of high-frequency operated milling spindles, the speed range being from 3,000 to 18,000 rpm and controlled by regulation of the motor power frequency.

Picture of the new die sinker is shown at the far left, on the opposite page. It is designed for fully automatic copy-milling of three dimensional forming tools with a surface finish quality of 0.00008-0.002 in.

Economic Facts on West Germany: ***Although World War II left German industry practically devastated, today their dollar exports are reaching staggering figures. In 1949, the total volume of West German machine tools (exclusive of presses) was $13.4 million. At the end of 1953, this figure had jumped to almost $189 million.***



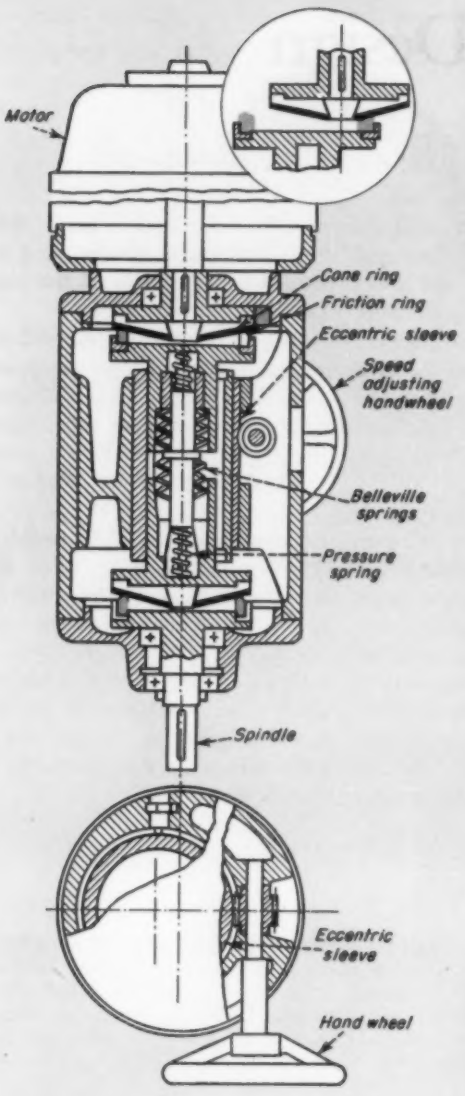
(A) TRACER HEAD VIEW shows use of right-angled pre-loaded ball bearings to maintain parallelism of tracer rod. Movement of the rod is translated to coupled hydraulic control valves. Each valve, in turn, controls the direction and rate of oil flow to a particular slide cylinder.

(B) PRE-SELECTION ATTACHMENT on top of the tracer rod. Plastic ring inside of sleeve is driven through two magnetic clutches, one for each direction of rotation. Ball fits inside of ring and imparts, when ring rotates, because of the difference of the radii between ball and ring, a circular probing action to the tracer rod. As soon as the rod contacts the master, ring rotation goes over to radial vibration, the neutral position of which adjusts the control pistons. As rod continues to trace, any change of the tracer-master contact angle will effect an automatic adjustment of the neutral ring position.

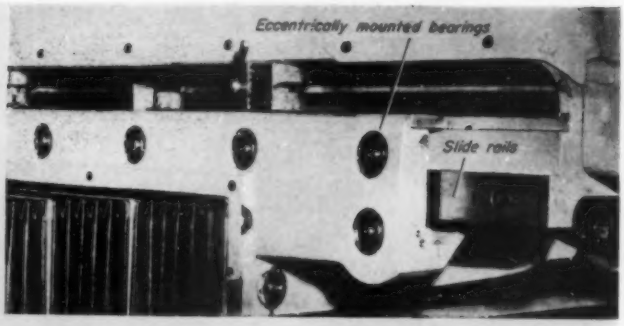
(C) WEIGHT of the vertical slide is balanced by the weight arrangement shown. Earlier designs were built around hydraulic cylinder balancing, but possibility of power failure was behind switch to new method.

(continued on next page)

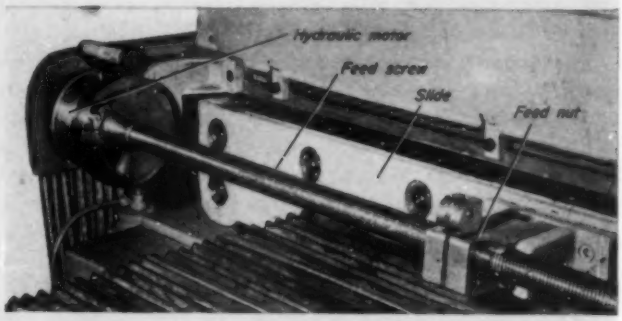
Die Sinker (continued)



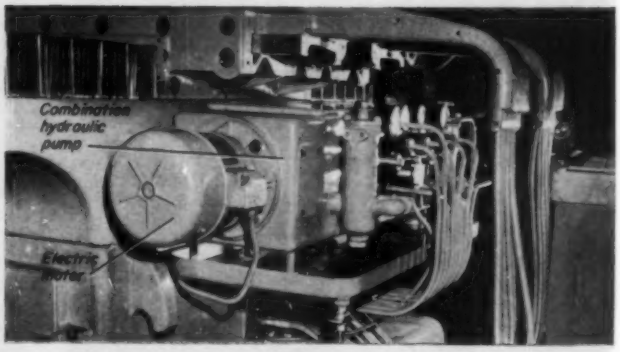
SPEED REDUCTION for working spindles is obtained with German designed "Pyrm Gear". Operation consists of moving a set of plastic friction rings across the face of stationary cones, the rings transmitting the rpm corresponding to the portion of the cone radius they contact. Cross-section shows position of cone and ring for maximum speed. Insert view shows their relative position for low speed. Movement of the ring is made by rotation of the handwheel, the ring being mounted on an eccentric sleeve in contact with the wheel eccentric screw.



THE THREE FEED MOVEMENTS are operated hydraulically by longitudinal, transverse and vertical slides. All slides run on roller guideways, the rollers running on hardened and ground steel rails. By mounting the bearings in eccentric housings, a positive and simple adjustment means is built into the machine.



PARALLEL FEED is obtained by a hydraulic rotary piston motor turning a feed screw engaging a feed nut attached to the longitudinal slide. Motor rotation can be adjusted to give feeds from 0.003 to 0.275 in.



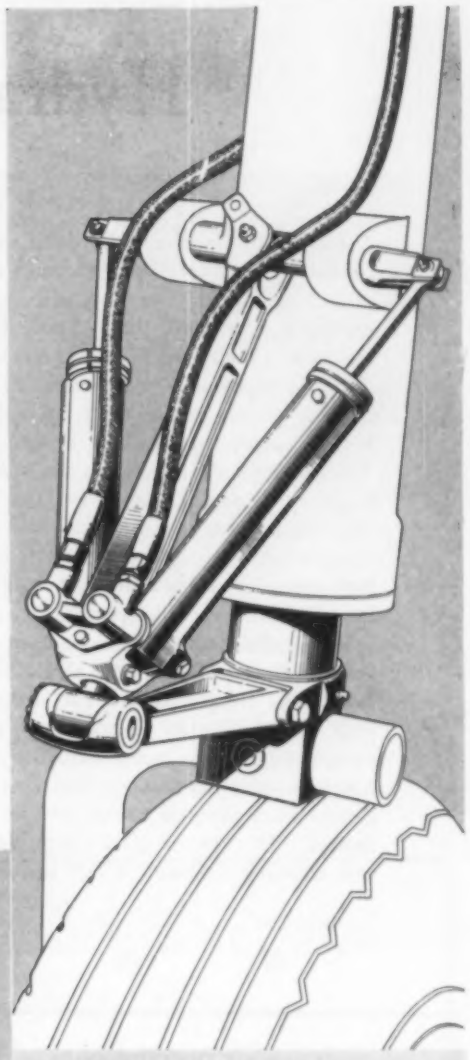
REAR VIEW of the machine shows mounting of hydraulic pump assemblies which consist of two separately driven units. Each pump is made up of a variable delivery section and a positive displacement section, both on the same shaft. The screw type or positive displacement sector supplies a constant pressure for the system, the piston pump used to regulate rate of flow desired.

Torque-Link Design Simplifies Aircraft Steering

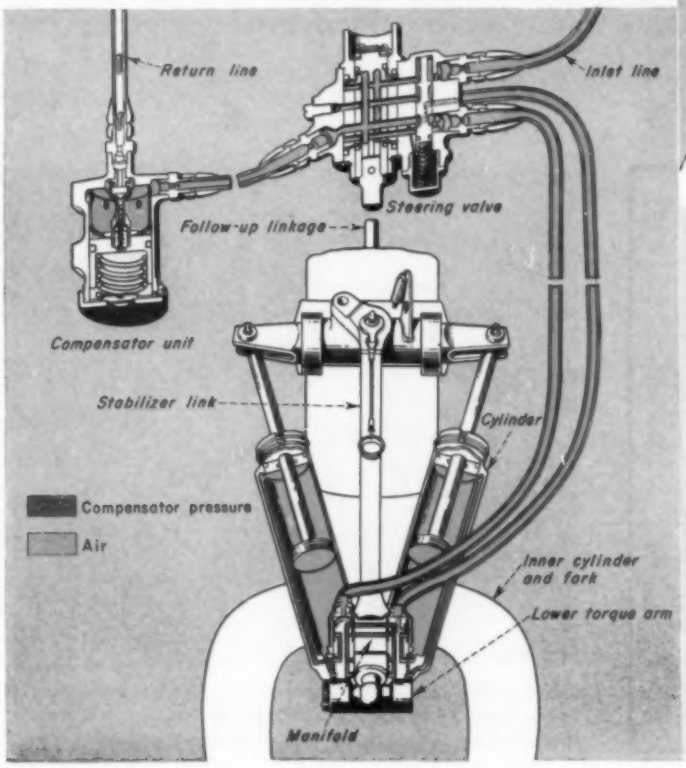
Savings in weight, space and maintenance are realized in the design of a new aircraft nose wheel steering system recently developed by Bendix Aviation Corp., South Bend, Ind.

Built in as an integral part of the nose strut, the new steering gear design consolidates the functions of two conventional mechanisms. Hydraulic power cylinders replace the upper scissor members of usual torque links, the cylinders operating both as torque links and steering actuators. In addition, dampening action is more effective since dampening forces are applied at a point having the least amount of spring action in the system.

The nose wheel steering motions during taxi, take-off and landing runs are controlled by the pilot, his actuation of the steering valve directing the oil flow to the cylinders.



SKETCH of the torque-link steering gear installed on a nose strut of a modern aircraft. A new design for more efficient steering action, the principal advantages lie in savings in weight and simplicity of construction.



SCHEMATIC DIAGRAM which is shown at left illustrates the steering system in static neutral position with the system pressure off. Steering pilot valve is operated by the pilot moving a steering control. The compensator located on the return side of the system is designed to constantly compensate for volumetric changes.

Hydraulics Rescue Sherman

Faced with the growing need for a vehicle powerful enough to recover modern tanks under variable combat conditions, Army Ordnance turned to Bowen-McLaughlin-York, Inc., York, Pa. with this question: Could any piece of reserve or salvage combat equipment be readily and inexpensively rebuilt to contain necessary lifting and towing gear having simple, precise and dependable controls? What resulted was the Army's newly designated T74 Recovery Vehicle, a converted World War II M4A3 Sherman medium tank now capable of a 85,000 lb straight line horizontal pull or a 50,000 lb hoist—both operations being conducted at full torque within an infinitely variable speed range.

While the hydraulic components are standard units, engineers of the Dudco Div. of New York Air Brake Co. (they designed the hydraulic system) built into the design an additional element. Pilot control valves were incorporated to give the operator a tangible relationship between the amount of control lever pressure exerted and the winch speed desired. This feature gives a high degree of operator sensitivity, a factor which amounts to a functional boost for the vehicle: It is equally effective removing and replacing delicate fire control assemblies as rescuing a 100,000 lb tank trapped by the terrain.

A two-section pump driven by a power take-off from the engine transmission supplies a constant oil delivery to the winch and brake circuits. One part of the pump is connected to the winch motor system, the other part is used to release the winch brakes when necessary. With this arrangement and using pilot valves to set up the proper oil flow, the amount of necessary components is kept to a minimum, extremely important in the space limitations set by converting an existing vehicle.

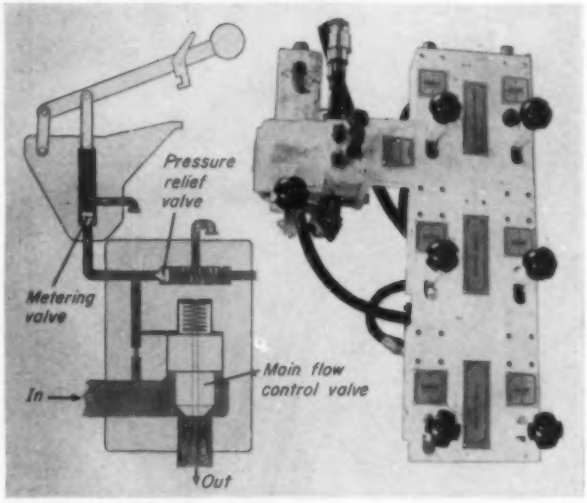
Space limitation requirements are also pointed up by the compact mounting and grouping of the hydraulic valves and their connecting elements. The main valve sub-plate which is fitted into the right side of the hull is drilled with oil passages to connect the orifice, relief and control valves necessary for the operation of the various components. Likewise, the boom, winch and brake controls are similarly mounted on a single plate.

NOTES ABOUT THE COMPANIES

To Bowen-McLaughlin-York, Inc. rebuilding of Ordnance combat vehicles is big business. During the last 4 years alone, they have rebuilt and modified over 5,000 World War II tanks, a good percentage of which were pressed into service to stem the initial Communist advance in Korea. At the present cost of $200,000 each for today's Patton 48 tanks, rebuilding at a fraction of the cost brings practical realism to the price of preparedness.

* * *

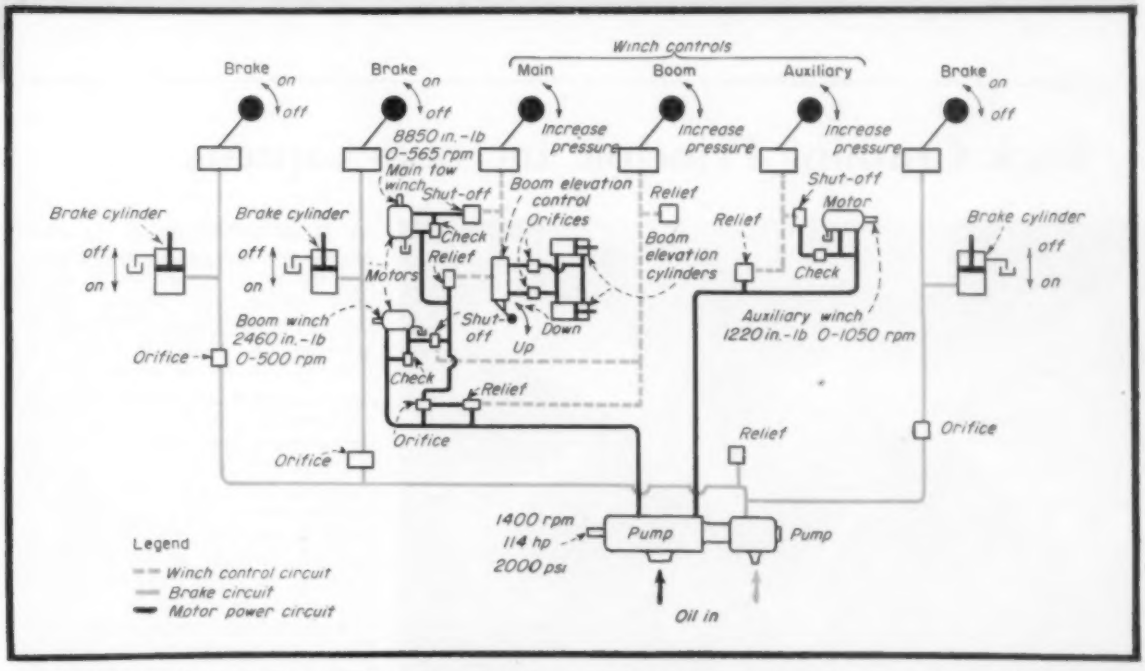
New York Air Brake Co., a potent force in the railroad air brake equipment market, has, since 1941, expanded its manufacturing facilities to the hydraulic equipment field. Cognizant of the rapid growth of hydraulic power transmission, the company has kept pace until it is now a major factor in the hydraulic industry. Last year, significantly, pointed up the fact that hydraulic sales now accounts for more than half of its $42 million gross income.



DESIGNED into each control is the direct relationship between lever pressure and variations in winch speed to keep the operator constantly aware of increased winching speed.

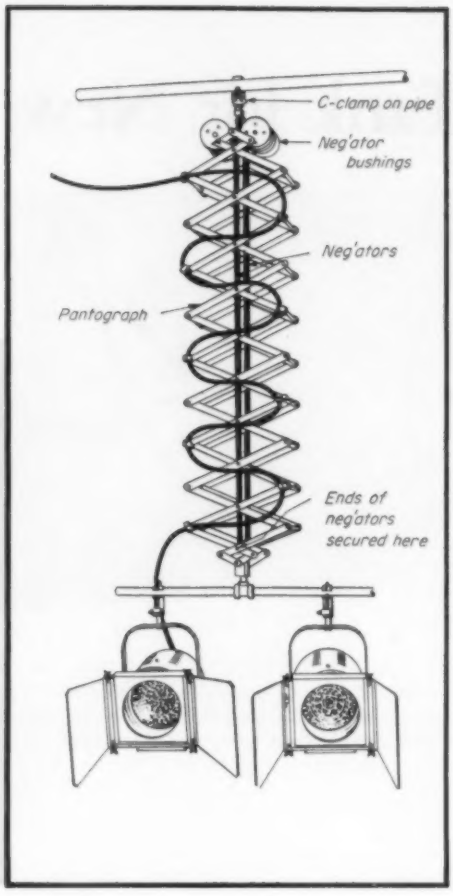
Tank for New Use

PACKAGED HYDRAULICS enabled the outmoded Sherman tank to be quickly converted into a highly versatile recovery and maintenance vehicle. Capable of towing damaged tanks cross country as well as hoisting or winching a tank out of mud or deep ditches, the new unit is equipped with a special track for added traction. The vehicle also has installed on it . . . . A specially designed spade located on the front of the body and which is lowered to dig into the ground to stabilize the vehicle for extremely heavy lifting or pulling. The spade is also designed for bulldozing operations, a factor which permits the operator to improve the terrain prior to the start of a recovery operation or to dig tank emplacements.



ADAPTABILITY of standard hydraulic components into a special performance package is illustrated by this power and control circuit diagram. The system—a charged, pressurized type operated by pilot control valves—is designed to transmit full torque to all winches regardless of the speed at which the winches are operated.

Shifting Neg'ator Ends Varies Counterbalancing Force

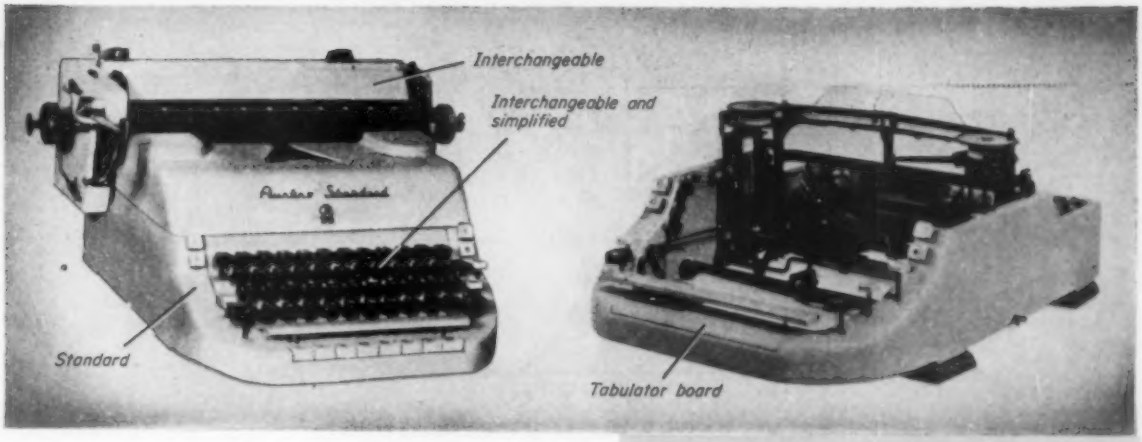


ANOTHER USE of the neg'ator as a counter balancing device (see *Product Engineering*, July 1953, pp 168-169) is illustrated by the sketch shown at the right. Designed by Century Lighting, Inc., N. Y., N. Y., this spotlight pantograph assembly is used to permit a set of four constant-force neg'ators to exert 20 lbs each to counterbalance fixture loads from 5 to 65 lbs, in addition to the 15 lb weight of the pantograph, at any point from 1½ to 12 ft from the top. Since the two 6-in. spotlights in the figure weigh 25 lbs, only two neg'ators are made active, the ends of both being secured on the bottom cross rod of the assembly.

The 10 sections of the pantograph give a load differential of 6 lbs per section or 1½ lbs per section per neg'ator. This load increment has been found sufficient to handle all weights under 65 lbs, friction in the joints being sufficient to take up smaller differences. Counterbalancing force is changed by shifting the ends of the neg'ators to any cross rod linking the center joints of the pantograph. The neg'ators are manufactured by the Hunter Spring Co., Lansdale, Pa.

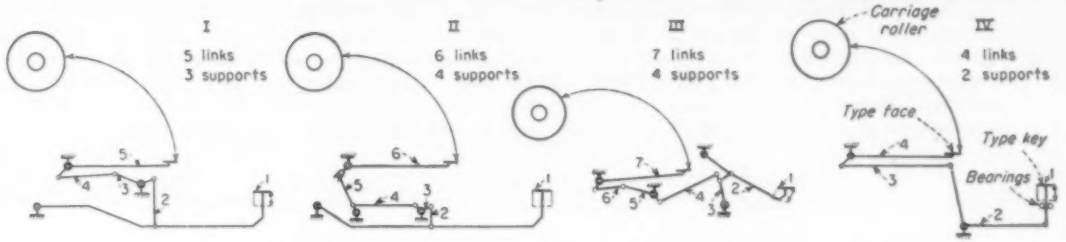
Rock Crushing Principle Increases Capacity

BY DESIGNING one of the rotors of their new rock crusher to be concave and the other convex—both having axial corrugations equally spaced around the periphery—Waldrip Engineering Co., Hollydale, Calif. have come up with a construction giving a marked increase in capacity over conventional designs. In one application the crusher is producing ¾ in. material at the rate of 140 tons per hour; size reduction being 4:1. The rotors are independently driven, the corrugations being in constant mesh to force the material through at the peripheral speed of the rotors. Spacing between the rotors is maintained by a combination hydraulic-gas accumulator system. The oil assures positive pressure between the rotors, the gas allows sufficient compression to permit the passage of trap iron.



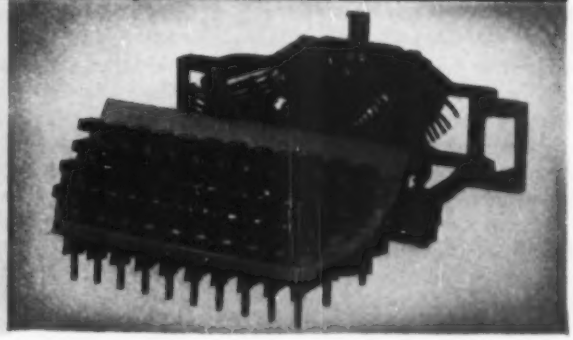
Interchangeable Parts Give Typewriter Maximum Flexibility

AUSTRIAN APPROACH to the international typewriter market is the new Austro Standard S-20; a model featuring exchangeable type-key sets, carriages and roller. Standard frame takes all non-typing keys required for operation. Frame of the typewriter not only houses interchangeable type-key set and various width carriers but also contains backspacer, ribbon reverse, margin key, ribbon color key and variable touch lever. Front cross member of the frame has a space for a 6-key tabulator system.



A MARKED SIMPLIFICATION of the type-key transmission system is another feature of the stationary model. According to the designer, Ernst Stingl, the new linkage consist of only 4 links and 2 supports compared to the 5-7 bar links in present-day machines. Shown are systems in current use and new design. Note use of the set of ball bearings in Austrian transmission to combine ease of operation with accurate guiding of the vertical movement of the key lever to the carriage roller.

TYPE-KEY set features only 4 links in the transmission saving about 100 parts as compared to conventional linkage systems. Entire assembly is designed for quick removal as a unit; a feature which points up widely divergent applications. Carriage interchangeability allows basic machine to be easily adaptable for typing on standard width paper up to legal width. A special lock built into the mechanism permits the carriage to move in either direction.



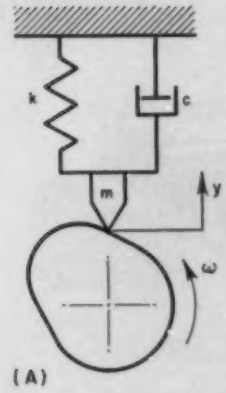
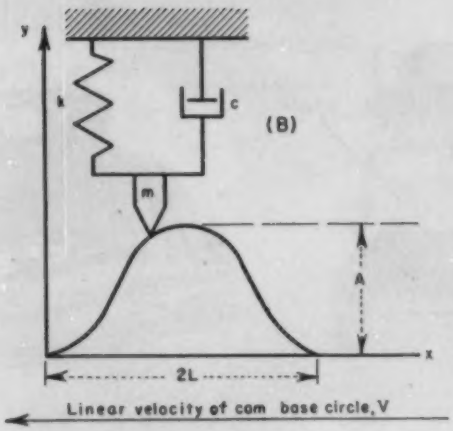


Fig. 1



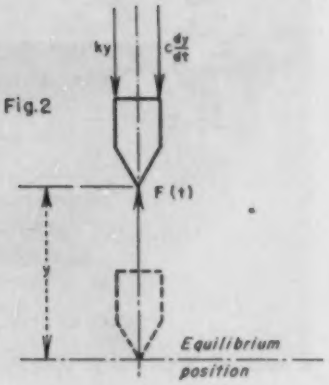


Fig. 2

When Will A Cam Follower Jump

An analytical study of how profile, flexibility, mass and rotating speed determine when a follower will leave the surface of its cam; this condition being defined as jump. Simplifying the system that represents the majority of practical applications, data are compiled for three cam forms—parabolic, harmonic and cycloidal. These data will be useful both as a guide for determining whether or not a basic design is susceptible to jump and for indicating what parameters should be changed to correct such a condition when it is encountered.

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MOST CAM APPLICATIONS can be represented by the system shown in Figs. 1(A) and (B). This system is characterized by the cam geometry, speed of operation V (or angular velocity, ω), damping coefficient c, spring stiffness k, and moving mass m.

Letting y be the displacement of the mass from the equilibrium position, the force diagram in Fig. 2 leads to the following equilibrium equation of the follower:

$$F(t) - c\frac{dy}{dt} - ky = m\frac{d^2y}{dt^2} \qquad (1)$$

For a given cam contour, $y = g(x)$, and a given operating speed, Eq (1) can be solved for $F(t)$, the force exerted by the cam on the follower. Since this force is zero when the follower leaves the cam, the solution of Eq (1) at $F(t) = 0$ establishes the criteria for jump.

These criteria have been determined for three specific cam contours—harmonic, cycloidal and parabolic; the relative shapes of these three cams are illustrated in Fig. 3. Theoretical velocity and acceleration curves for them can be found in nearly all design textbooks and the references at the end of this article discuss other dynamic design factors. Only their jump characteristics are considered herein.

For the harmonic cam, the profile is given by:

$$y = A/2\,(1 - \cos \pi x/L). \qquad (2)$$

Or for constant translational cam speed,

$$y = A/2\,(1 - \cos \omega t)$$

where

$$\omega t = \pi x/L$$

Differentiating the cam curve, and substituting these derivatives into Eq (1) with $F(t) = 0$ leads to the fol-

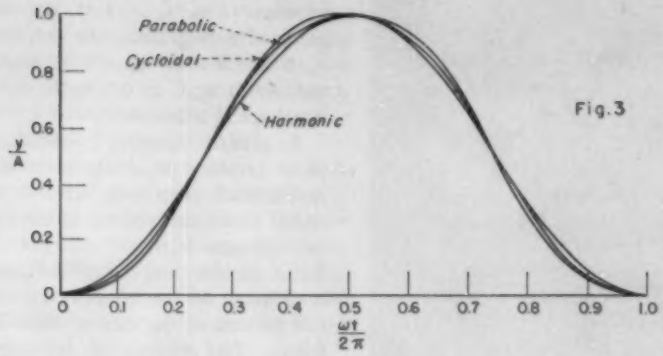

Fig. 1—Sketch in (A) shows the cam-follower assembly used by the authors to get jump criteria for harmonic, parabolic and cycloidal cam forms. (B) and (C) are schematic diagrams of systems for which these data apply.

Fig. 2—Free body diagram of cam follower. When the follower leaves the cam surface, $F(t) = 0$. This condition is used to establish the jump criteria.

Fig. 3—Comparison of parabolic, cycloidal and harmonic cam shapes.

Table 1— Summary of Jump Characteristics

Cam Form	Equation of Cam Profile	Jump Criteria (x_b is point at which jump occurs)
Harmonic	$y = \frac{A}{2}\left(1-\cos\frac{\pi x}{L}\right)$ $y = \frac{A}{2}\left(1-\cos\omega t\right)$ where $\omega t = \frac{\pi x}{L}$	$\frac{\omega}{\omega_n} = -\frac{1}{2}\tan\frac{\pi x_b}{L}\left\{\frac{c}{m\omega_n} \pm \left[\left(\frac{c}{m\omega_n}\right)^2 - \frac{4}{\sec\frac{\pi x_b}{L}+1}\right]^{\frac{1}{2}}\right\}$
Cycloidal	$y = \frac{A}{\pi}\left[\omega t - \frac{1}{2}\sin 2\omega t\right]$; $0 \le \omega t \le \pi$ $y = \frac{A}{\pi}\left[2\pi - \omega t - \frac{1}{2}\sin 2(2\pi-\omega t)\right]$; $\pi \le \omega t \le 2\pi$	$\frac{\omega}{\omega_n} = -\frac{c}{4m\omega_n}\tan\frac{\pi x_b}{L} \pm \frac{1}{4}\left[\left(\frac{c}{m\omega_n}\right)^2\tan^2\frac{\pi x_b}{L} - 4\left(\frac{2\pi x_b/L}{\sin\frac{2\pi x_b}{L}}\right)\right]^{\frac{1}{2}}$; $0 \le \frac{x_b}{L} \le 1$ $\frac{\omega}{\omega_n} = -\frac{c}{4m\omega_n}\tan\frac{\pi x_b}{L} \pm \frac{1}{4}\left[\left(\frac{c}{m\omega_n}\right)^2\tan^2\frac{\pi x_b}{L} + 4\left(1+\frac{4-2\pi x_b/L}{\sin\frac{2\pi x_b}{L}}\right)\right]^{\frac{1}{2}}$; $1 \le \frac{x_b}{L} \le 2$
Parabolic	$y = \left(\frac{2A}{\pi^2}\right)(\omega t)^2$; $0 \le \omega t \le \frac{\pi}{2}$ $y = A\left[1-\left(\frac{2}{\pi^2}\right)(\omega t-\pi)^2\right]$; $\frac{\pi}{2} \le \omega t \le \frac{3\pi}{2}$ $y = \frac{2A}{\pi^2}(\omega t - 2\pi)^2$; $\frac{3\pi}{2} \le \omega t \le 2\pi$	$\frac{x_b}{L} = \frac{1}{\pi}\frac{\omega}{\omega_n}\left\{\frac{c}{m\omega_n} \pm \left[\left(\frac{c}{m\omega_n}\right)^2 - 2\right]^{\frac{1}{2}}\right\}$; $0 \le \frac{x_b}{L} \le \frac{1}{2}$ $\frac{x_b}{L} = 1-\left(\frac{1}{\pi}\right)\left(\frac{c}{m\omega_n}\right)\left(\frac{\omega}{\omega_n}\right) \pm \left\{\left(\frac{1}{\pi}\right)^2\left(\frac{\omega}{\omega_n}\right)^2\left[\left(\frac{c}{m\omega_n}\right)^2 - 2\right] + \frac{1}{2}\right\}^{\frac{1}{2}}$; $\frac{1}{2} \le \frac{x_b}{L} \le 2$ $\frac{x_b}{L} = \left\{2-\left(\frac{1}{\pi}\right)\left(\frac{\omega}{\omega_n}\right)\right\}\left\{\left(\frac{c}{m\omega_n}\right) \pm \left[\left(\frac{c}{m\omega_n}\right)^2 - 2\right]^{\frac{1}{2}}\right\}$; $\frac{3}{2} \le \frac{x_b}{L} \le 2$

lowing criterion as a limit for jump:

$$\omega/\omega_n = -(1/2\tan(\pi x_b/L)\left\{c/m\omega_n \pm \left[(c/m\omega_n)^2 - \frac{4}{\sec(\pi x_b/L+1}\right]^{1/2}\right\} \quad (3)$$

where x_b is the point at which jump occurs,
and

$$\omega_n = (k/m)^{1/2}$$

These data are summarized in Table I. In an analagous manner, similar data for the parabolic and harmonic cams were developed and are also presented in this table.

The equations defining the point at which jump occurs for each of the three cam forms, given in the right-hand column of Table I, are shown in dimensionless form in Figs. 4(A), (B) and (C), for various values of positive damping ratios $c/m\omega_n$. Physically possible solutions are limited, in all three charts, to the region bounded by the cross-hatched lines and, consequently, these curves can be used as a guide for selecting cam profiles and/or operation speeds, as will be demonstrated. The analysis presented herein is restricted to positive quantities and thus precludes application to systems in which negative resistance is present. Furthermore, no attempt is made to prescribe the follower motion subsequent to initial jump, or to predict the ensuing jump points.

Within the above qualification, some basic and general conclusions can be formulated by studying the characteristics of these curves. Each of the three forms will be taken separately.

Harmonic Cam

It is evident from Fig. 4(A) that for zero damping, the jump point for harmonic cams is restricted to that portion of the cam lying between $x_b/L =$ 0.5 and 1.0. Furthermore, for zero

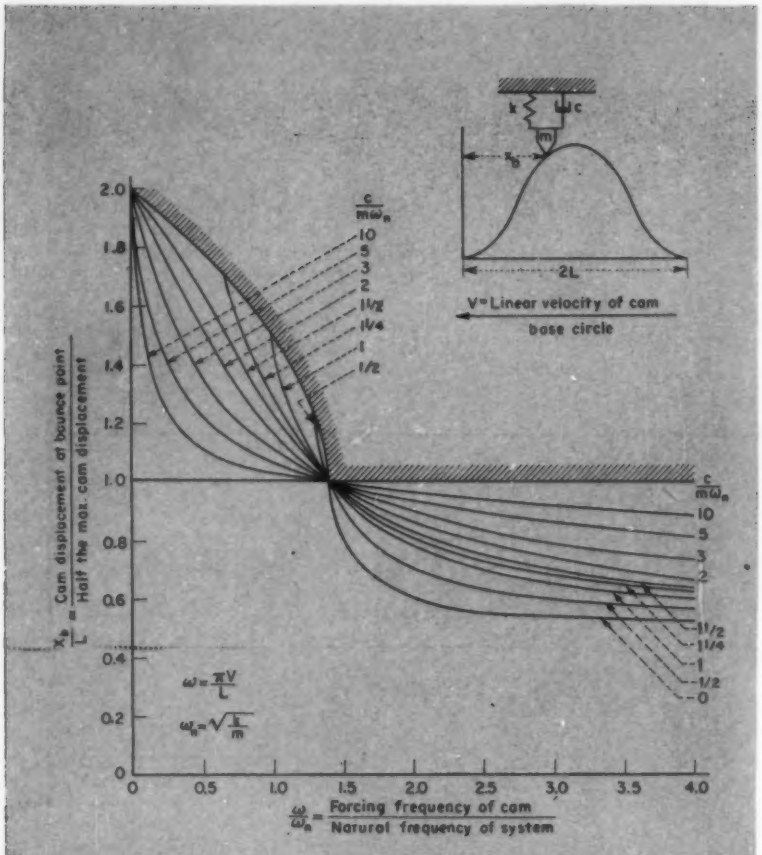

Fig. 4 (A) JUMP CRITERIA IN HARMONIC CAM

damping, jump occurs only at speeds in excess of $\omega/\omega_n = 1.41$, the jump point advancing along the cam from $x_b/L = 1.0$ at $\omega/\omega_n = 1.41$ assymptotically to $x_b/L = 0.5$ as the operational speed is increased.

As positive damping is introduced, jump becomes physically possible at speeds lower than $\omega/\omega_n = 1.41$ and occurs in the fall portion of the cam, i.e., between $x_b/L = 1.0$ and 2.0. But if the damping is kept sufficiently low, jump can be eliminated in the fall portion of the cam at these low speeds. The presence of damping at speeds in excess of $\omega/\omega_n = 1.41$ merely acts to retard the jump point. For a system having a given damping, an increase of operational speed above $\omega/\omega_n = 1.41$ leads to an advance of the jump point.

Cycloidal

Consider now the cycloidal cam characterized by the family of curves of Fig. 4 (B). For zero damping, as for the harmonic, cam the region of jump is restricted and occurs only at speeds in excess of $\omega/\omega_n = 1.19$, the jump point advancing with increasing

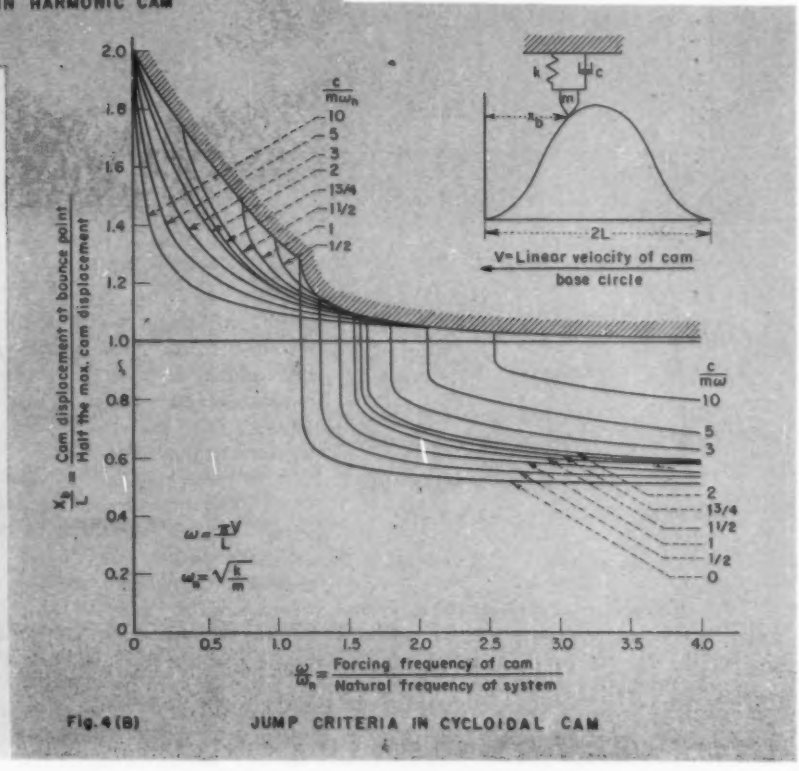

Fig. 4 (B) JUMP CRITERIA IN CYCLOIDAL CAM

Fig. 4—Jump criteria for the following cam forms: (A) Harmonic, (B) Cycloidal and (C) Parabolic. These curves show that the operating range in which the follower will leave the cam profile is smaller for the parabolic than either the harmonic or cycloidal cam. For the harmonic and cycloidal forms, with zero damping, jump can only occur at speeds represented by values of larger than 1.41 and 1.19, respectively. However, as positive damping is introduced, jump can occur at progressively lower speeds. Although the performance of parabolic cams is not so simply defined, it does offer advantages at high speeds.

speed from $x_b/L = 0.7$ assymptotically to $x_b/L = 0.5$. As positive damping is introduced, the region wherein jump is physically possible at speeds less than $\omega/\omega_n = 1.19$ expands and, as for the harmonic cam, if the damping is kept sufficiently low, jump at low speeds may be eliminated. At high operational speeds, the performance is similar to the harmonic cam. The most interesting differentiating characteristics between the harmonic and cycloidal cam lies in the discontinuities observed in the jump criteria of the cycloidal cam.

Consider in Fig. 4(B), for example, the case of a system having a damping $c/m\omega_n = 1.5$, and observe the effect of increasing the operational speed. At very low speeds, that is, ω/ω_n less than 0.36, jump does not occur; at a speed $\omega/\omega_n = 0.36$, jump develops at $x_b/L = 1.73$. As the speed is increased the jump point advances along the fall portion of the cam up to the point $\omega/\omega_n = 1.56$ at which speed $x_b/L = 1.09$. At the infinitesimally higher speed, jump develops at approximately $x_b/L = 0.8$. This single discontinuity in jump characteristic is typical of the cycloidal cam.

Parabolic

The curves in Fig. 4(C) show the jump characteristic for a parabolic cam. For the case of zero damping, jump is confined to the region $x_b/L = 0.5$ to 1.0 at speeds between $\omega/\omega_n = 1.1$ and 1.57. With the presence of positive damping, the characteristic curves become confusing and are best illustrated by Fig. 5, which shows an expanded region of Fig. 4(C).

Consider a system with damping factor $c/m\omega_n = 0.25$. Then, from Fig. 5, it is evident that jump is restricted to speeds between points *a* and *c* and contains a characteristic discontinuity. Furthermore, it is noted that between *a* and *b* an increase of operating speed advances the jump point; at *b* a reversal of the progression of the jump point occurs; further increase of speed to point *c* retards the jump point. This general behavior occurs for damping factor $c/m\omega_n$ up to approximately 0.82. The dash line in Fig. 4(C) represents the locus of the point *c* as the damping is varied.

It is obvious that, if jump is not desirable for this particular case of $c/m\omega_n = 0.25$, the speed must be kept either lower than $\omega/\omega_n = 0.93$ or greater than $\omega/\omega_n = 1.59$. For values of damping $c/m\omega_n$ greater than approximately 0.82, this discontinuity is eliminated, see Fig. 4(C), and the consequent characteristic curves intersect the boundary $x/_bL = 0.5$, providing a design guide for the selection of minimum required damping to eliminate jump at high speeds.

From the preceding discussion, it is seen that jump can be eliminated at certain damping ratios and low speeds for the harmonic, cycloidal and parabolic cam. However, the parabolic cam has a distinct advantage compared to the other two forms in that jump can be eliminated at high speeds.

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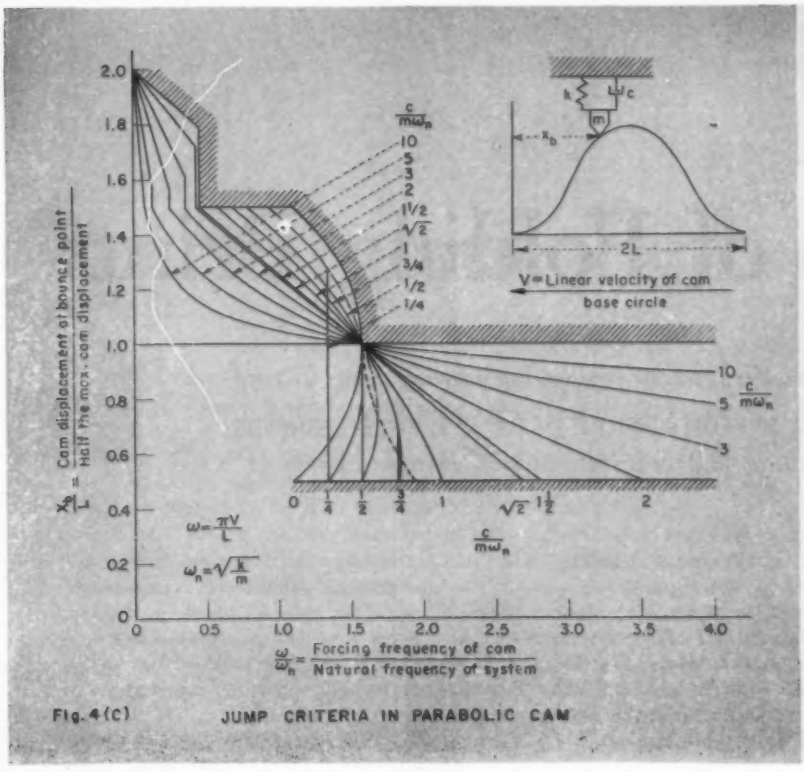

Fig. 4(C) JUMP CRITERIA IN PARABOLIC CAM

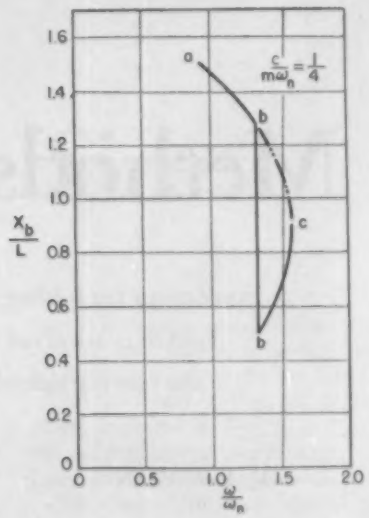

Fig. 5—Illustrative example of jump in a parabolic cam for a damping ratio of 0.25.

Instructions for Folding Prints of Drawings

Dimensioned fold lines for protective folding are shown in Fig. 1; for exposed folding in Fig. 2; and for book filing in Fig 3.

Size	Dimensions, in.	Comments
A	8½ x 11	No fold required.
B	11 x 17	Fold into halves. Cannot fold to bring title-block into correct location. Auxiliary number block required as shown in Fig. 2. For book filing, fold back to expose title-block.
C	17 x 22	Fold into halves and quarters. For book filing of size C and larger, fold into narrow horizontal concertina parallel to top edge, then into vertical concertina.
D	22 x 34	To locate title-block to best advantage, igonore that this size is 2 x 11 in. by 4 x 8½ in. and instead treat it as approximately 3 x 8½ in. or 25½ in. by 3 x 11 in. or 33 in. Fold into thirds both ways.
E	25 x 40	Or approximately this size. Fold short side into thirds, the long side into multiples of 11 in. as shown.
	Up to 28 x 44	Treat same as size E. Folded print will be 9⅓ x 11 in. If 9⅓ in. is too wide, must fold same as size F.
F	34 x 44	Fold top three-quarters into a triple concertina on horizontal lines. Then fold into quadruple concertina on vertical lines. Finally fold into two halves along horizontal line. Alternatively, for protective folding, fold into halves and quarters on vertical lines instead of concertina fashion; this method gives a dog ear over the title of a single thickness instead of triple thickness.

Methods of Folding Prints

Instructions for folding standard sizes of engineering drawing prints to letter size. Fold lines are given for protecting the viewing side of prints, for exposing the viewing side of prints, and for prints that are filed in book binders.

W. L. GOVAN

ONE IMPORTANT, though often neglected, engineering department operation is that of folding prints. Usually, in the performance of this operation, little thought is given as to how the original folds affect convenience in future handling, use, and filing of the prints.

A print refolded along new fold lines still retains the creases of the original folds and is awkward to handle in a flat unfolded state. For this reason, few prints are ever refolded to a new overall size.

Unless prints are originally folded to a uniform overall size, many inconveniences ensue in handling, mailing, loose filing in letter-size drawer type cabinets, binding in loose leaf books, or binding with sales proposals, contracts, and instructions.

Prints received through external or

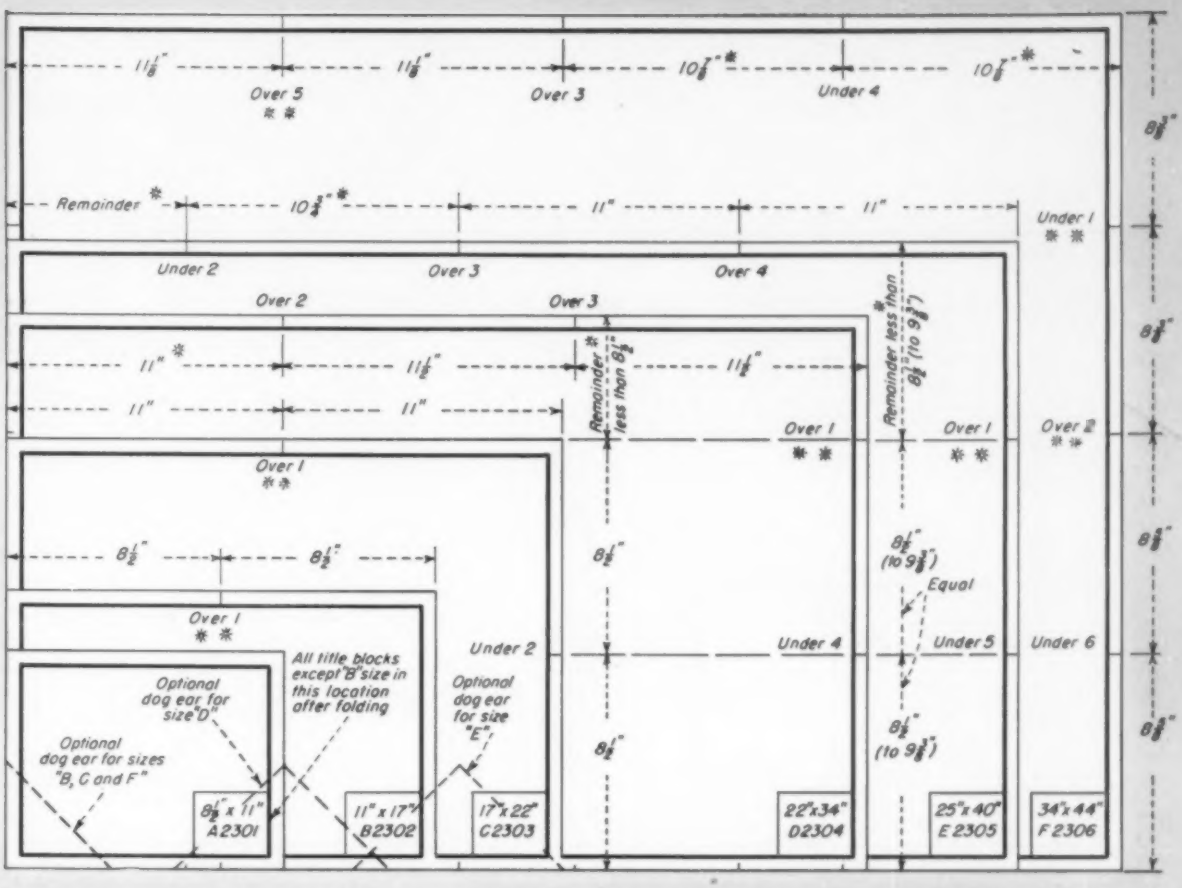

Fig. 1—Fold lines for protective folding that exposes only the blank reverse side. For protective folding only, folds marked with a single asterisk must be shorter than adjacent folds. For exposed folding, folds marked with double asterisk are reversed.

to Standard Letter Size

internal company mail are usually filed still folded in miscellaneous sizes as received. The results are bad housekeeping and an inefficient use of filing space. This undesirable situation could be avoided if both company prints and those received from outside sources were all folded to a uniform size.

Presumably to facilitate folding to a uniform filing size, most standards call for drawing sizes to be multiples of 8½ x 11 in. letter-size paper. Few engineering departments, however, specify how folding is to be done. To be folded down to the letter size, drawings do not need to be a multiple of 8½ x 11 in. as long as fold lines are selected accordingly.

Many good reasons may be given for completely ignoring the relationship of the standard letter size to the overall dimensions when folding prints. Some of these reasons are: It is easier to fold a print when all the folds are not exactly the same size; standard mailing envelopes will take larger than letter size; the title-block should be in its normal lower right-hand position after folding; and because a binding edge is often required beyond the folds.

The preferred method of folding prints, indicated in Figs. 1 to 3, and the accompanying instructions, are based on the following considerations:

The final folded size should approximate letter size, 8½ by 11 inches.

The thickest fold should be made in as few thicknesses of paper as possible, say a maximum of four to six. Somewhat in contradiction to this objective, a minimum of fold lines is

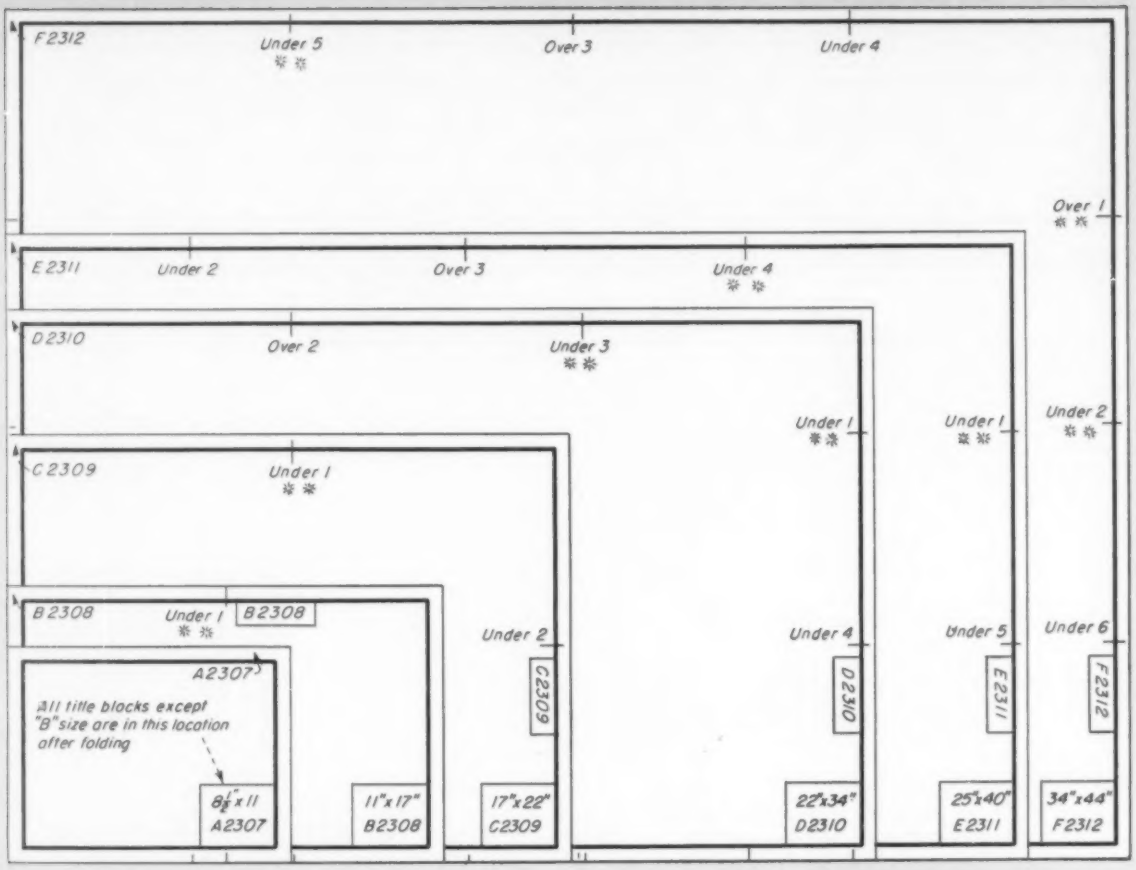

Fig. 2—Fold lines for exposed folding. For dimensioned location of fold lines see Fig. 1, except that dimensions marked with a single asterisk may be equalized for exposed folding. For protective folding, folds marked with a double asterisk are reversed.

desirable. Folding by halving, then quartering, and so on, requires a minimum number of folding operations, but the folds are bulkier than when the print is folded concertina fashion.

For filing in a letter-size cabinet, the top edge of the print should be a single fold line. This type of fold helps to avoid any possibility of filing a later print inside the folds of a former one.

Title-blocks should appear, if possible, in the lower right-hand corner of folded prints. This requirement can be readily fulfilled with every usual standard size except 11 x 17 in., commonly called "B" size.

The fold lines for protective folding shown in Fig. 1 satisfy the needs of engineers who prefer that prints be folded so as to protect their viewing side. This method is especially good when the folded print receives rough handling either in or out of the files.

In Figs. 1, 2, and 3, the word "under" means that the portion of the print above the horizontal fold line, or to the left of the vertical fold line, is to be folded underneath, away from the observer. The word "over" means that the fold is upward, toward the observer.

Only the blank reverse side of a print is exposed when the preferred fold lines shown in Fig. 1 are followed. The title-block is obscured. It can be made visible, however, by folding back one corner of the print in a triangle or dog ear.

Alternatively, another title-block can be stamped on the reverse or white side of the print in the most suitable corner. The laborious task of copying the title and drawing number into the new title block obviously makes this method impractical if there are many prints to be filed.

A title-block in a corner of the reverse side of prints received from outside may be stamped on when a local filing number and additional information are to be added.

The fold lines for exposed folding shown in Fig. 2 meet the requirements of engineers who prefer that prints be folded to expose the viewing side and title-block. If the print is to be studied a section at a time, this method is probably the most convenient.

Note that the same fold lines and the same sequence of folding can be used both for protective folding, Fig. 1, and for exposed folding, Fig. 2. The only difference is that some of the folds are reversed.

With the exposed type of folding, Fig. 2, the title-block is clearly visible. Offices that produce prints destined to end up in some other company's files can cater to the requirements of the ultimate user by:

1. Providing additional blanked-out

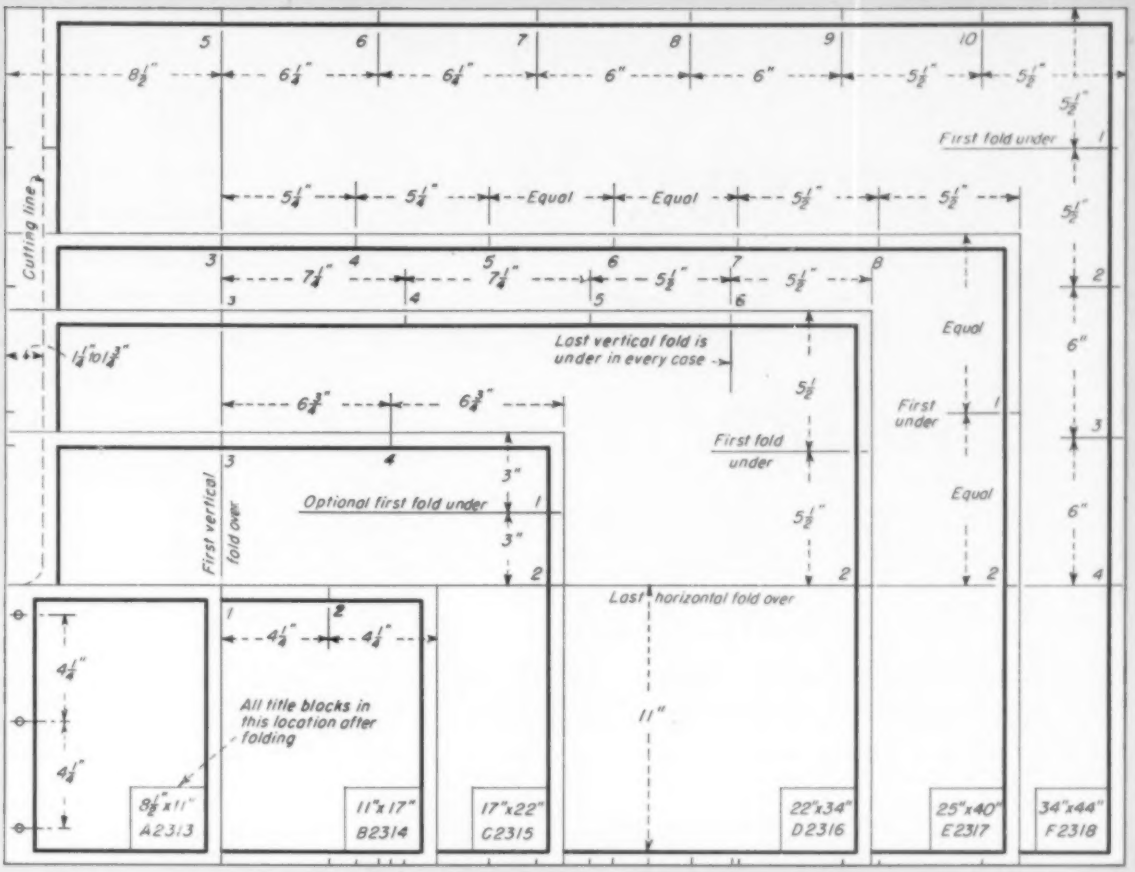

Fig. 3—Fold lines for book filing. First make all horizontal folds in concertina fashion and then follow with vertical concertina folds. For prints enclosed with text matter, this method provides a binding edge, exposes the tile block, and makes a neat package.

spaces in the title-block for local filing numbers and additions to be the title, such as location of the equipment.

2. Repeat the drawing number in an auxiliary box so that it appears on the top right-hand corner of the folded print when placed in the file.

3. Repeat the number a third time in inverted form in the top left-hand corner of each drawing, so that unfolded prints and drawings can be identified from either top or bottom.

Preferred fold lines for prints that are filed in book form binders are shown in Fig. 3. The horizontal folds are made first in concertina fashion and are then followed by vertical concertina folds, thus the total thickness of any one fold is reduced. This method provides a binding edge and exposes the title-block. For prints enclosed with text matter, this method makes a neat self-contained package, but is very awkward with large prints; that is, if anybody takes the trouble of studying them in connection with the text.

When folded as indicated in Fig. 3 and bound in a book, only the viewing side of the print is visible from the front. No section of blank paper, especially the white side of the blue prints, mars the appearance of an open book. The title-block is exposed in the customary lower right-hand corner. Depending on the format of the drawing, the exposed upper right-hand corner of the print may be an advantage since the bill of material or other data usually placed there would be visible.

For book filing of any print wider than 11 in. it is, of course, necessary that a binding tab projects out about 1½ in. wide by 11 in. high along the lower portion of the left hand edge of the unfolded print. A special offset cutting line and border for this tab may be printed on the drawing form. For any type of binding, draftsmen should keep clear a binding margin about 1½ in. wide along the left side of all drawings.

Fold lines should be indicated on the printed drawing forms in the margins. Such indications are not only a help to the staff who do the folding, but enable draftsmen to avoid putting figures on or near a fold line. In many instances, zoning lines can be made to coincide with fold lines if zones are used. It is not necessary to identify the fold lines by abbreviations or numbers to indicate the sequence of folding, or whether the lines are for book or loose filing. The personnel concerned with the routine operations of folding prints can be readily instructed with regard to sequence. They will probably mark off or arrange their working table to facilitate folding to standard sizes.

Design Recommendations for

Removing Heat From Electronic Equipment

The operating temperature of electronic equipment is influenced by both circuit and mechanical design considerations. Here are some design tips that will increase the transfer of heat from electronic devices by natural means.

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THE RELIABILITY of electronic equipment can be improved by increasing the rate of heat transfer from the various circuit elements. This is primarily a mechanical design problem if it is assumed that the initial circuit design was based on the use of components that produce the smallest heat output in line with proper performance. An assembly should be designed so that the developed heat is transferred along a thermal bus to the ultimate thermal sink.

Eighty-five to ninety percent of the total heat is usually developed in the cathode of the vacuum tubes. These tubes dissipate heat through the pins via conduction, and through the glass envelope via radiation. Convection currents are usually relied upon as the thermal bus to carry the radiated heat to the thermal sink. Since these currents are generally of a low velocity nature, poor convection efficiencies result unless metering holes and/or baffle systems are provided. However, a substantial portion of the tube heat can be transferred away by thermal conduction if the tube mounting device is designed properly. Fig. 1 shows three types of tube mountings that can also be used as electrostatic shields and heat-transfer paths for subminiature tubes. Mountings are of aluminum.

The first two mounts, (A) and (B), are recommended where vibration forces are small and where insertion from an end is possible. The third is recommended for severe duty and snap-action side insertion. The first mount offers a heat-transfer advantage of 5 to 10 C over the other two. Welding or soldering the mounting device to the back plate, rather than riveting, further lowers the tube temperature.

The tube terminal leads should be heavy with the connection located as close to the tube as practical to give maximum thermal conduction through the tube leads and to reduce the possibilities of electrolysis. Where weight restrictions permit, the tube shield thickness should be $\frac{1}{16}$ in. This results in a 10 percent decrease in tube-to-sink temperature difference. However, further increasing tube shield thickness yields diminishing returns.

Most conventional tube shields are poor thermal conductors. Regardless of whether good thermal conduction to the chassis can be established, the thin wall of the shield causes large temperature gradients along the shield. Modifications of existing conventional shields to improve heat transfer are not satisfactory. However, Fig. 2 shows a miniature tube shield that incorporates good thermal design.

The following shows the tube envelope temperature as a function of shield wall thickness.

Wall Thickness	Tube Temperature
$\frac{1}{32}$ in.	241 C
$\frac{3}{16}$ in.	211 C

The air gap must not exceed the $\frac{1}{8}$ in. space, Fig. 2, and preferably should be as small as practical since the effect of increased gaseous conduction thus obtained is greater at all altitudes than that produced by slotting the shield for improved convection. Fig. 3 shows a typical slotted shield.

The type of shield shown in Fig. 3 is recommended for use with components of irregular shapes, such as open-type transformers and relays. For such components, the slots promote convective heat transfer and are particularly effective with the larger air gaps present between the shield and the irregularly shaped surfaces. This type of shield is applicable to pressurized equipment and not suited to low pressure environments, such as high altitudes.

Where feasible, aluminum investment castings made of two halves can encompass complete assemblies. The tubes are embedded in a good heat conducting plastic such as Silastic, and are placed in the cavities. The assembly is then fastened to an adequate thermal plate. These cast assemblies are capable of 125 C operation.

Heat transfer can be further improved by using $\frac{5}{16}$ in. diameter metering holes directly under the tubes. These will cause low velocity convection currents; however, proper arrangement of the components is essential for maximum efficiency.

In some applications, reflective insulation can be used to obtain a de-

Table I

Column A Temperature difference C	Column B Square inches of case per watt of dissipation
130	1.50
120	1.70
110	2.05
100	2.40
90	2.88
80	3.40
70	4.05
60	4.85
50	6.00
40	7.60

Table II

Surface	Comparative Dissipation Color Factor
Etched	1.00
Brown Anodizing	1.12
Green Anodizing	1.20
Red Anodizing	1.28
Orange Anodizing	1.32
Black Anodizing	1.32
Blue Anodizing	1.44
Purple Anodizing	1.52
Flat Black Paint	1.60
Black Crackle Lacquer	1.80

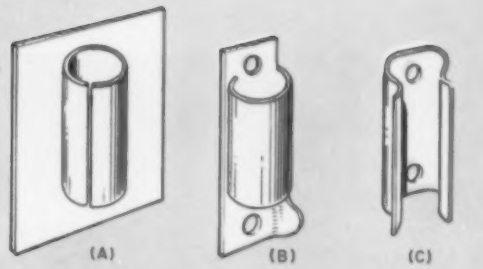

Fig. 1—Three types of tube mountings. (A) and (B) are for light duty. (C) is for severe duty use.

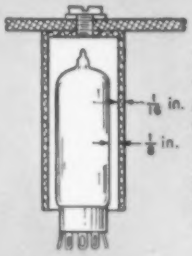

Fig. 2 — Tube shield designed for good thermal characteristics.

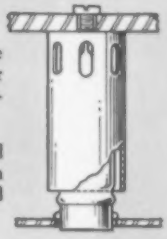

Fig. 3 — Slotted shield for use with irregular shaped components.

signed thermal gradient in high temperature assemblies. For example, at 200 C the ratio of the radiation intensity of stainless steel to that of a black body is about 70 percent when oxidized at 1,200 F for 48 hours. Therefore, temperature sensitive circuits can be mounted separately from the heat source by the use of these reflective insulators.

Hermetically sealed electronic packages can be liquid cooled. With power densities of 0.5 watts per square inch of cooling surface or less, it has been found satisfactory to immerse the electronic parts directly in a coolant, such as some of the silicone oils. Precautions must be taken to make sure that the coolant is compatible with the components so as to reduce the effects of decomposition, corrosion, electrolysis, and dielectric resonances. In one application, a pure mineral oil was used as a coolant for a 0.3 cubic foot pulse microwave transmitter, operating in the 200 to 3000 MC region while dissipating 183 watts in a 65 C ambient temperature. The temperature rise for this unit was held to 55 Centigrade in this manner.

Where regulated power supplies are required, it is sometimes possible to use external line regulators. This will remove some of the power dissipating devices from the package. Also, when practical, voltage dropping resistors should be kept external to packaged units. Preferably these resistors should be mounted close to the ultimate thermal sink, which is usually the main chassis, with the small dimension perpendicular to the sink to reduce the conduction path.

The following gives a step-by-step procedure for designing a package for compact electronic equipment. This will permit a given number of watts to be dissipated and limit the case temperature rise to some prescribed value.

(1) Select the desired maximum internal temperature and the maximum external ambient temperature which will prevail, and subtract one from the other, bearing in mind that the internal temperature limit may be dictated by the eutectic point of solder. This is generally about 183 Centigrade.

(2) Referring to Table I, locate this temperature difference in Column A and determine the square inches of etched aluminum case required for each watt to be dissipated from the corresponding value in Column B.

(3) Multiply this number by the total number of watts that will be dissipated. This product is the minimum surface area required when using etched aluminum.

(4) The required surface area can be reduced by dividing the value by a dissipation color factor, various values of which are given above in Table II.

(5) Further reduction in surface area can be obtained by the addition of integral fins, the total surface area of which should be about 4 or 5 times the difference between the desired surface area and the actual calculated surface area. The fins can be cast, machined on thin strips bonded to the case.

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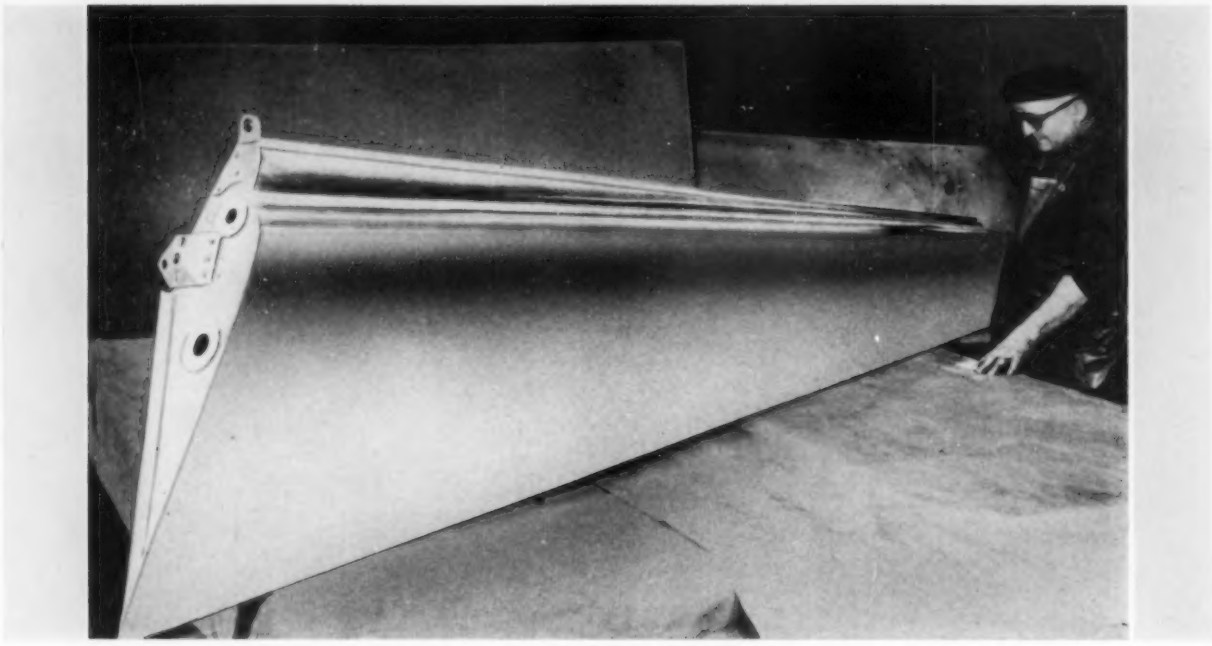

Metal to Metal Bonding With

Epoxy Resin-Based Adhesives

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OF THE MANY ADHESIVES introduced during the past few years for metal-to-metal bonding, the epoxy resins have been making the most rapid advances. The major reasons for their influence in assembly design are:

1. Retention of bonding strength at temperatures up to 180 F.
2. Low volume shrinkage during cure.
3. "Contact pressure" cure at moderate temperature.
4. High degree of resistance to chemicals.
5. Absence of placement-disturbing volatiles.
6. Availability in readily handled forms—liquid, paste or stick.

The high degree of adhesion exhibited by the epoxy resins is attributable to two important factors—they readily "wet" metal surfaces and cure with low shrinkage.

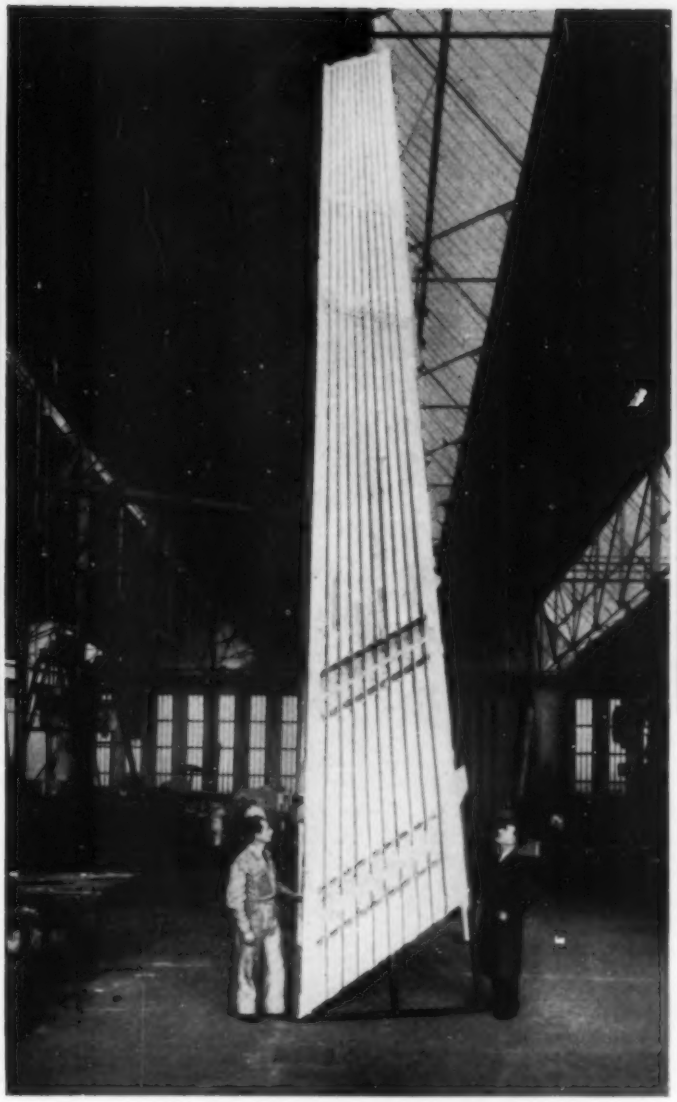
The low surface tension exhibited by the epoxy resins accounts, in part, for their good "wetting" characteristics.

Volume shrinkage, which is part and parcel of the polymerization (curing) process, is only about 4 percent in the epoxy adhesives. This low figure means the final bond is stronger than with many adhesives because stress concentrations in the resins close to the bond are low.

As with any metal-to-metal adhesive, epoxy bond strength is a product of cohesion as well as adhesion.

The characteristic which enhances cohesion is the existence, at room temperature, of considerable mutual attraction between the resin molecules.

Because of the rather extensive entanglement of the molecules, this attraction is the dominant factor in imparting hardness and mechanical strength to the resinous mass. Yet with this close packing of interlaced and tangled chains, there still remains sufficient space for some movement of



(LEFT) Skin and interior bracing of wing flap manufactured by the Societé Nationale de Construction Aeronautique de Sud Ouest are bonded with epoxy resin-based adhesives. Smooth "clean" surface free of fasteners is desirable both in production and in service to improve efficiency.

(RIGHT) Another representative example of a commercial assembly bonded with epoxy resin adhesive is this wing section with stiffeners showing.

Bond characteristics, strength under static and impact loading, and application factors for adhesives that simplify the assembly of sheet metal structures are presented.

the segments under impact loading without destruction of the bonds.

The high degree of molecular entanglement also improves the structure of the joint. This structure consists of a great number of epoxy molecules attached to the metal surfaces, and linked together in all directions.

Tensile Shear Strength

Typical mechanical strengths obtainable from an epoxy resin adhesive are illustrated in Table I. The corresponding requirements of the Air Force Specification No. 14164 are included in this table for comparison. Naturally, these strengths vary with the type of metal being bonded. At room temperature, double lap tensile shear strength of an epoxy resin bond on 52S aluminum is 8,100 psi. On other materials, it is lower, approaching 7,600 psi on chrome-nickel steel, and dropping to approximately 7,000 psi on copper and mild steel.

The tensile shear strength of this type adhesive over a range of temperature is shown graphically in Fig. 3(A). A specially compounded adhesive blended from epoxy and phenolic resins has been developed for applications up 500 F, but this adhesive is not as yet in commercial production.

The strengths attainable with a hot-melt stick adhesive cured for one hour at 392 F are reported as values of double lap shear strength. Fig. 3(B) shows how the strength decreases with rising temperature.

The effect of joint thickness on strength is shown by tests on tensile shear specimens prepared with Epon adhesive VIII, Fig. 3(C). The constancy of strength within wide limits of bond thickness makes it possible to assemble large sections where accurate matching of parts is not always possible. It also permits the use of low assembly pressures, since minimum glue-line thickness does not appear to be required as a factor in obtaining maximum efficiency with the adhesive.

Load Bearing Characteristics

When a tension load is applied to a bonded joint, the metal surfaces begin to separate. Initial movement produces tension in some of the adhesive molecules. These immediately readjust their segment positions so that some of the other chains take part of the load. After the "slack" is out of every segment, all the adhesive chains together carry the load, resulting in a condition of static loading.

It is possible, however, to apply the load faster than the segments can adjust themselves. When this impact type of loading occurs, the result is stress concentration on a molecular scale. If the initial load bearers fail under the sudden stress, the failure will spread. As is true of most organic adhesives, the epoxy resins show substantial reduction in strength when the loading rate is changed from static to impact conditions.

Filler is a controllable factor which can materially affect impact strength. Measurements on an epoxy resin adhesive indicated that its Izod impact with out filler is 5.2 ft-lb/sq in. With 20 percent asbestos, its impact resistance increases to 18.0 ft-lb/sq inch.

When a mechanical shock wave enters a bonded joint through the boundary of a filled adhesive layer, it encounters both the resinous mass and the filler particles. The wave will pass through the filler faster than it will travel through the resin if the elastic modulus-to-density ratio is greater for the filler. This applies to most inorganic fillers. The result of this higher speed is that the shock wave is spread over a greater volume in a shorter time than would be the case if no filler were present. In designing adhesive joints subject to impact load, every opportunity should be utilized so that the load will encounter the adhesive bond throughout as large an area as possible.

The impact behavior of epoxy resin bonds is similar to that exhibited by polymethyl methacrylate, in which measurements were made at ambients less than the softening temperature. In acrylic material, the impact strength decreases stepwise as the rate of loading is increased, indicating there is more than one type of segment in the polymer. Since each type has its own length and mass, each also has its own natural period of time required to shift position. At the speed of loading is increased, more segments are unable to adjust to the load.

Fortunately, an increase in temperature assists in the adjustment. This raises the impact strength and, effectively, shifts the curves slightly to the right. At higher temperatures, any one set of segments may have greater mobility and therefore conform at higher rates of loading.

ASTM data support this impact strength—temperature relationship. At —70 F, the impact value is 7 ft-lb/sq in.; at room temperature, it climbs to 15 ft-lb/sq in. The rise to 17 ft-lb/sq in. at 180 F is at a proportionately slower rate.

Application Factors

Adhesives can be divided generally into two categories: those which are applied from solvent and those which are 100 percent reactive material. The epoxy adhesives are 100 percent reactive and require no removal of solvent prior to curing. These reactive preparations can be further divided into two groups based on whether or not volatile products are formed during curing. The epoxy adhesives do not produce these dangerous products —a definite advantage in metal bonding where there is little chance for escape of these vapors. This safety factor is especially important in bonding sealed hollow structures or in laminating metal.

Epoxy adhesives are supplied in three forms. One is a clear amber viscous liquid to which curing agent and filler are added by the user. This form affords considerable flexibility in the use of fillers, coloring agents and other additives.

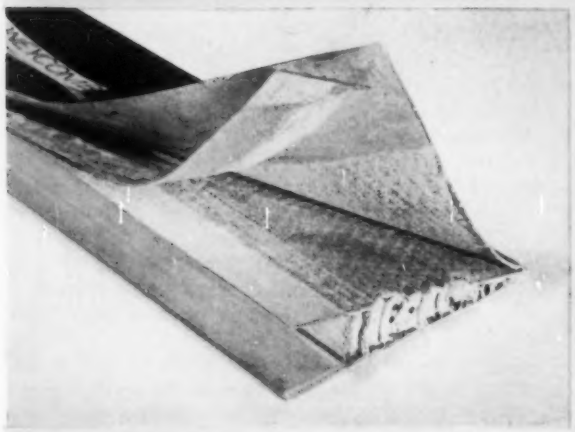


Fig. 1—Peeled back section of trailing edge. Skins are bonded to honeycomb with layer of epoxy adhesive and layer of cheese cloth.

Fig. 2—Special paste type epoxy formulation is used to fill honeycomb sandwich panels either in small spot for drilling and tapping or along one edge for finishing.

Many suppliers furnish compounded epoxy adhesives in paste form to which a specified quantity of curing agent is added. In these formulations, a desirable balance has been attained between static and impact strength throughout a given temperature range.

The third form of epoxy adhesive is a solid stick which melts at about 200 F. This adhesive is applied by rubbing the stick on the preheated parts.

Treatment of the surfaces prior to adhesive application varies with the metals being bonded. Good adhesion to aluminum requires the complete removal of all oily matter, followed by a chromic acid etch which facilitates "wetting" of the metal. When a more inert metal such as stainless steel is to be bonded, a thorough degreasing is required. Here, the chromic acid treatment does not contribute much to better "wetting" characteristics.

Epoxy adhesives have good flow characteristics and are quite fluid during cure. They require only "contact" pressure to force them into place, and there being no volatiles, a placement is not easily disturbed.

Curing of epoxy resin adhesives can be accomplished at any point within a wide temperature range. The paste and liquid forms can be cured at room temperature (70 F and up) in a period of days. When diethylene triamine or similar curing agents are used, full strength is developed at 70 F in about two or three days. Maximum strengths, however, are obtained with some hot curing. Excellent hot cures are obtainable within 90 minutes at 200 F with amine curing agents. The stick form of hot melt adhesive requires 280 F for a few hours, or about 30 min at 400 Fahrenheit to reach cure.

Toxicity

Since epoxy resin adhesives are relatively new, only limited toxicity information is available. The curing agent component of these systems is known to be toxic. Thus, adequate ventilation should be provided in the handling of these adhesives to prevent undue exposure to vapors, and skin contact should be avoided. If accidental skin contact occurs, the exposed area should immediately be washed with soap and water. No difficulties should be encountered if these normal precautions are observed.

The present and continuing development, therefore, of these metal-to-metal adhesives indicates one clear fact—that they will be used increasingly to reduce size, increase production, and cut down the need of fastening in metal structure assembly.

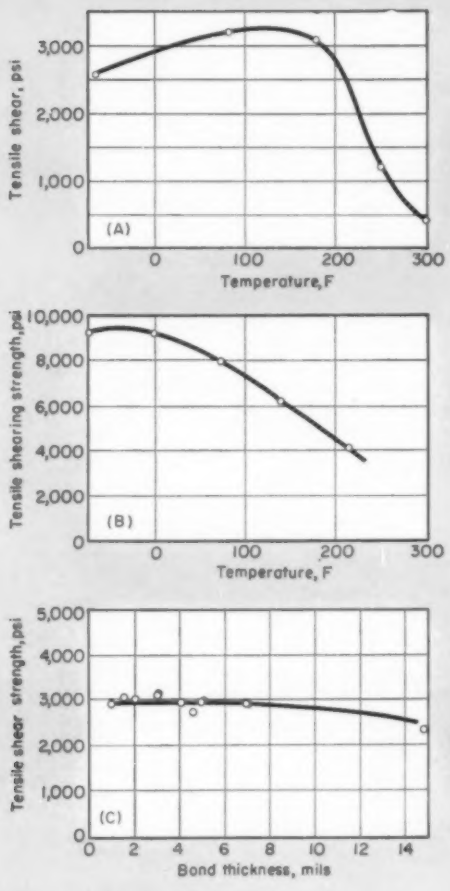


Table I—Typical Mechanical Strengths of Epoxy Resin Bonds*

Mechanical Property	Typical Value	USAF Spec. 14164
Tensile Shear Strength, psi		
At −70 F	2,600	2,500
At 77 F	3,200	2,500
At 180 F	3,100	1,250
At 250 F	1,200	
At 300 F	400	
Izod Impact Strength, ft-lb/sq in.	14	10
Bond Strength, lb	175	150
Long Time Strength (200 hr), psi		
At 77 F	3,100	1,600
At 180 F	2,200	800
Tensile Shear, psi at 77 F after:		
30 da in tap water	4,200	2,000
30 da in salt spray QQ-M-151	3,100	2,000
7 da in ethylene glycol	3,000	2,000
7 da in anti-icing fluid AN-F-13	3,100	2,000
7 da in hydraulic fluid AN-0-366	4,000	2,000
7 da in hydrocarbon AN-F-42	3,700	2,000

* Shell Epon Adhesive VIII on 24S-T3 Alclad Aluminum 0.064 in. thick.

Fig. 3—Shear strength of epoxy resin-based adhesive bonds: (A) Tensile shear strength of Shell's Epon Adhesive VIII over range of temperature; (B) double lap shear strength of Ciba's Araldite AN-100 cured one hour at 392 F; and (C) effect of thickness on strength of Epon Adhesive VIII. Flatness of last curve is significant.

Turbine Pumps—Their Design

Turbine pumps combine the high discharge pressure of

FIG. 1—In this design, the impeller, Fig. 1(A), is mounted between the bearings to keep shaft deflection to a minimum. The distribution of pressure during pump operation causes an unbalanced transverse pressure condition, which loads and tends to deflect the impeller shaft. When the load is applied midway between the bearings, the shaft diameter is kept to a minimum for a certain allowable deflection; the load on the bearings is equally divided. The hydraulic pressure on the two sides of the impeller is equalized by balancing holes in the impeller adjacent to the hub. This eliminates thrust loads on the bearings, caused by an unequal pressure distribution on the impeller.

The design simplicity of the turbine type pump makes it an easy matter to incorporate two or more impellers on a single shaft, Fig. 1(B). The only problem is to provide a shaft that is large enough to take care of the additional horsepower required to drive the pump.

Applications for single and multiple impeller pumps are: feeding boilers operating at pressures from 20 psi to 200 psi; returning condensate from heating systems to boilers; boosting pressures in water supply lines; transferring chemicals in chemical plants; transferring gasoline and other hydrocarbons in refineries.

FIG. 2—A popular design, especially in the smaller sizes, is the combined pump and driving motor, a close-coupled unit. The design simplifies the pump construction but requires special modifications to the design of the motor. The motor shaft must be extended to mount the pump impeller, and the motor end bell must be specially machined for mounting the pump shell. However, the combination makes a rugged, compact and efficient pumping unit. It requires only a minimum amount of space and maintenance, regardless of the number of stages used.

On most applications for turbine pumps in close-coupled assembly, the motor shaft should be of a corrosion-resistant

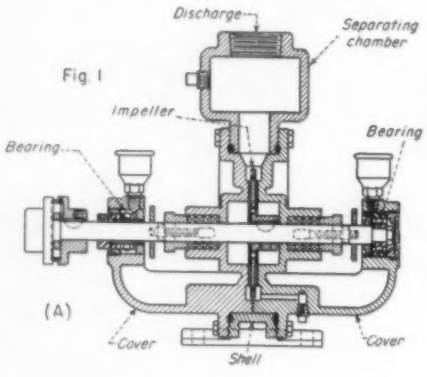


Fig. 1

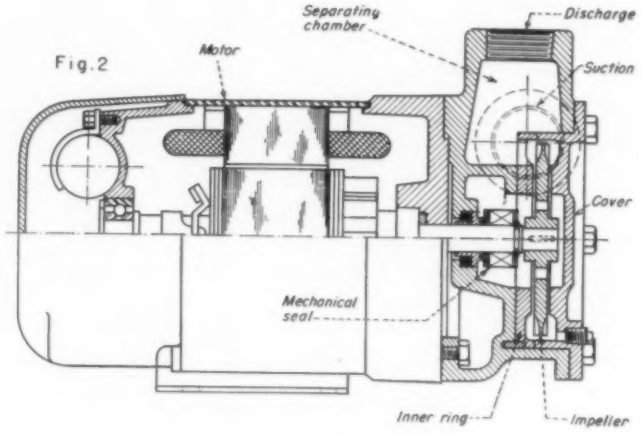
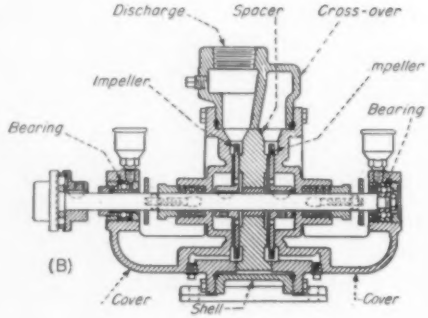


Fig. 2



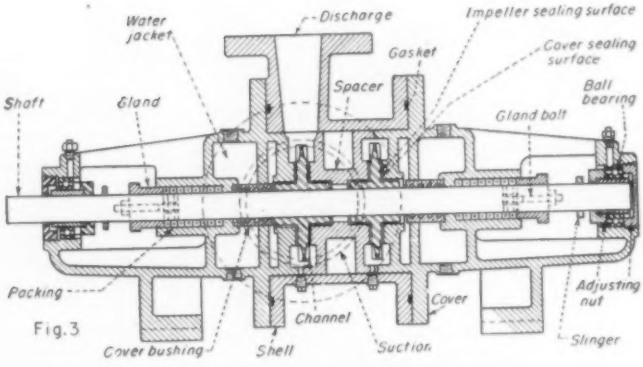


Fig. 3

and Application

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rotary types with the flexible operation of centrifugal pumps.

metal, since it is in direct contact with the liquid being handled. The design shown incorporates a mechanical seal instead of a stuffing box. This eliminates the possibility of scoring the motor shaft by packing friction and reduces the length of the unit.

Applications for the close-coupled pumps are: hot water circulation in heating systems; circulating coolants in air conditioning systems; emptying tanks or barrels; pumping water out of cisterns for sprinkling or house service; and liquid handling requirements for "package" type equipment with limited space for pump installation.

FIG. 3—In the handling of extremely hot liquids it is necessary to cool certain parts of the pump to prevent overheating and eventual pump failure. Water jackets are used to direct cooling liquid to those parts that are susceptible to failure by overheating. The jackets are isolated from the pump channels so that the pumped fluid will not be cooled. For the installation shown, the coolant circulates around the cover bushing and part of the stuffing box. This keeps the shaft and the packing cool. It also keeps the temperature of the bearing housing within safe limits.

In this type of pump, if the supporting feet were attached to the shell—as in the other designs—they would heat up because of the high temperature of the liquid being pumped. The resultant expansion would disturb the alignment of the pump and the driver; feet are, therefore, attached outboard of the water jacket. Coolant inlet is located at the bottom of the jacket, to obtain the maximum cooling on those parts most adversely affected by high temperatures.

Applications of the water jacketed pump are: pumping high temperature water from superheaters into boilers; circulating high temperature water in closed systems; hot oil charging service in refineries; circulating hot Dowtherm in closed systems; and handling hot caustics in refinery process service.

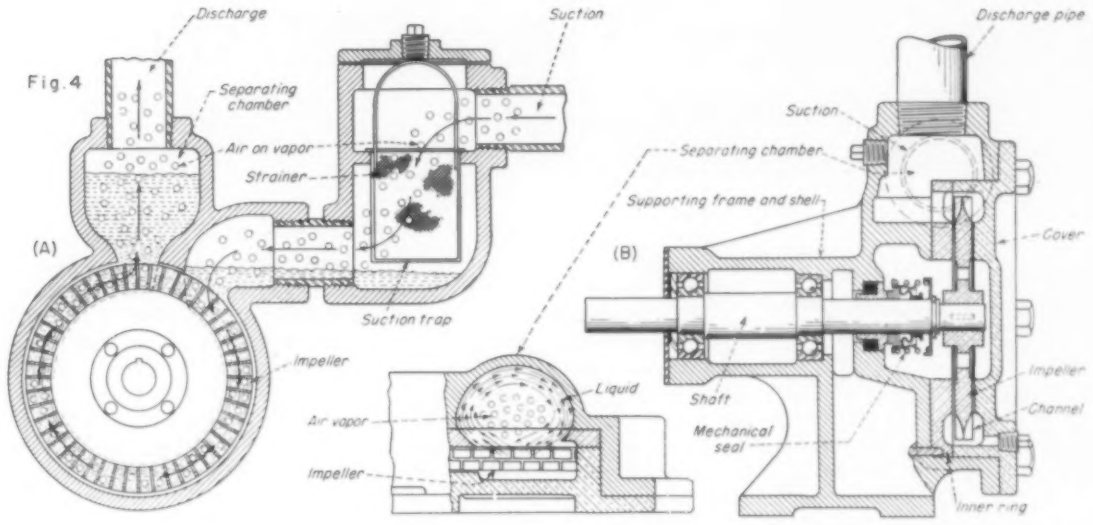

FIG. 4—Self-priming units can be added to the various pumps without redesigning. Structurally, the primer can be cast integral with the shell on the larger pumps. Two types are most often used: gravity feed and centrifugal action.

The basic principle of the priming unit is to separate the air or vapor from the liquid. The difference in specific gravity allows the air trapped in the liquid to rise to the surface and escape from the pump in the form of bubbles. To apply this principle, a quantity of liquid must be trapped in the pump. When the pump is started the liquid travels through the system, traps the air, and discharges it at the discharge opening. Eventually, the pump is free of air, and atmospheric pressure forces liquid into the pump.

A pump using an integral separating chamber and a separable trap is shown in Fig. 4(A). This is a gravity feed system. Action of the impeller draws liquid and air into the pump channel and through to the separating chamber. Air is expelled and the liquid .ecirculated.

A pump using centrifugal force to prime the pump is shown in Fig. 4(B). Liquid in the impeller buckets is discharged tangentially into the separating chamber and follows the wall of the chamber in a whirling motion. Liquid is returned to the impeller buckets at the outlet opening from the channel. During this cycle the air separates and seeks the center of the whirling body of liquid and then passes out through the discharge opening.

Table I—Properties and Producers of Available Heat Treatable Alpha-Beta Titanium Alloys[1]

Alloy	Producer	Composition, percent	Yield Str, psi	Ult Str, psi	Form
RC-130A	Rem-Cru Titanium, Inc.	Ti-8Mn	115,000	130,000	Sheet
RC-130B		Ti-4Mn-4Al	140,000	150,000	Bar stock
Ti-140A	Titanium Metals Corp.	Ti-2Fe-2Cr-2Mo	120,000	130,000	Bar stock
Ti-150A		2.7Cr-1.5Fe	120,000	135,000	Bar stock
MST 3Al-5Cr	Mallory-Sharon Ti Corp.	Ti-3Al-5Cr	135,000 [2]	145,000 [2]	Forging stock
RS-120	Republic Steel Corp.	Ti-7Mn	120,000	130,000	Flat rolled, and bar stock
RS-110		Ti-4Cr-2Fe	110,000	120,000	Flat rolled, and bar stock

[1] Properties taken from manufacturers' literature and do not constitute indorsement by authors.
[2] After hot forging 80 percent and furnace cooling.

The 3Mn Complex— A New Titanium Alloy

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COMMERCIAL PRODUCERS of titanium alloys have found that the addition of from 4 to 10 percent of a beta stabilizing element can increase the strength of the virgin metal twofold. The resulting hardening effect not only increases the "as is" hardness of titanium, but also promotes metastable (semi-stable) retention of the high temperature body centered structure. Hardening by coherency or dispersion can then take place as the metastable beta phase decomposes into the alpha and beta type structure upon aging.

All the commercial type alpha-beta (beta-stabilized) titanium alloys respond well to heat treatment, Table I, but they do not exhibit sufficiently high ductility when heat treated to high strength levels. An ultimate tensile strength of 180,000 psi appears to be the upper limit of heat treatment which gives satisfactory ductility.

In spite of the deficiencies exhibited by the present heat treatable titanium alloys, such as directionality in properties, low ultimate-to-yield strength ratio and elevated temperature contamination, the advent of heat treatable titanium alloys has added new thinking in design. And because of their high strength-density ratio, they offer new avenues of application, especially where a relatively strong, light metal can be used.

Development Program

During the past three years, Battelle Memorial Institute, under sponsorship by the United States Air Force, has been engaged in an extensive program to develop a high-strength, forgeable titanium alloy which could be heat treated to a desired strength level. The result of this investigation is the so-called "3Mn Complex" titanium alloy Its forging characteristics are excellent and its response to heat treatment is better than that of any commercial alloy introduced thus far.

Early in the investigation it was learned that certain beta stabilizing elements offered greater promise than the interstitial alpha stabilizers, carbon, oxygen and nitrogen. The 3Mn Complex composition evolved from a series of experimental alloys in which four of the five alloying elements were held constant at one percent while the fifth was varied. By raising the level of any one element from one to four percent, the properties of the system could be varied extensively. It was finally concluded that the alloy containing three percent manganese with one percent each of chromium, iron, molybdenum and vanadium had a remarkable combination of strength and ductility.

In the annealed condition, the ulti-

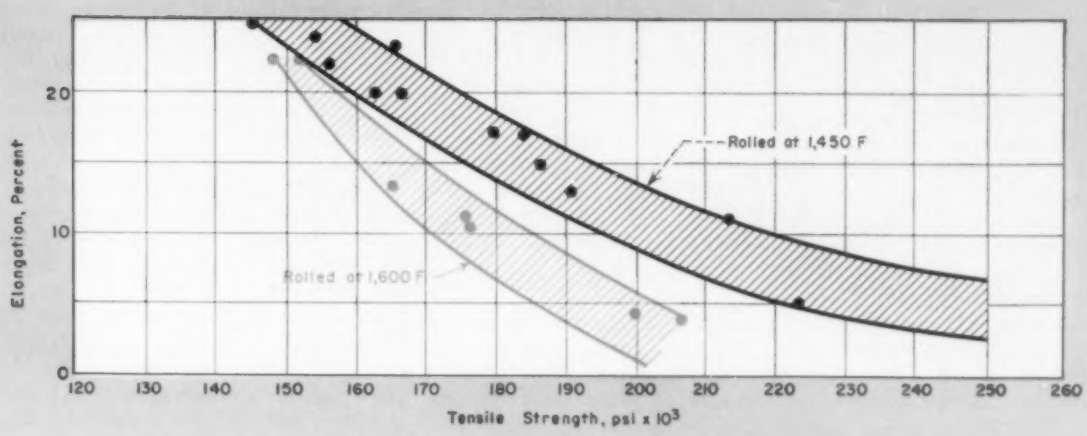

Fig. 1—Ductility of 3Mn-Complex titanium throughout wide strength range is noticeably influenced by rolling temperature. Alloy was solution treated at 1,300-strength levels. Loss in tensile and bend ductility of many titanium alloys after treatment above 1,500 F is not as yet fully understood.

Table II—Relationship Between Strength and Ductility of 3Mn Titanium for Two Solution H. T. Schedules

Aging Treatment	Tensile Str, psi	Red. in Area, percent	Elongation, percent (1″)
	H. T. One hour at 1,300 F; ice water quenched		
24 hr at 800 F	192,000	32	14
52 hr at 800 F	187,000	41	17
8 hr at 900 F	172,000	47	19
24 hr at 900 F	164,000	49	22
	H. T. One hour at 1,400 F; ice water quenched		
24 hr at 800 F	225,000	13	6
52 hr at 800 F	215,000	23	10
8 hr at 900 F	190,000	44	14
24 hr at 900 F	178,000	57	18

mate tensile strength of the 3Mn-Complex is about on a par with that of titanium alloys now available. The tensile properties of this alloy can range from 135,000 psi and 31 percent elongation in 1.0 in. to 222,000 psi and four percent elongation, depending on the heat treating cycle.

Recent studies have revealed that a transition structure, called the omega phase, is instrumental in hardening beta stabilized titanium alloys. The omega phase is found in the beta matrix of these alloys when they are solution treated and then aged at temperatures less than 900 F. This treatment hardens and embrittles the alloys. After prolonged aging, the omega phase disappears, and is replaced by a finely dispersed alpha structure. At the same time, the alloys become ductile, but still maintain useful strength. It is believed that the omega phase, coherent with the beta matrix, produces this brittle condition.

Heat treatment of the 3Mn-Complex is based on the disappearance of the omega phase. The alloy is solution treated in the alpha-beta temperature range (1,300-1,450 F), water quenched, and aged for periods from 8 to 24 hr at 800 or 900 F. During this "overaging" period, the omega phase forms, then apparently disappears by transforming into the alpha phase. Some authorities believe the age hardening phenomenon in the beta-stabilized alloys is closely related to the hardening mechanism in copper-aluminum alloys.

Maximum useful strength occurs during the early stages of overaging, after the omega-to-alpha transformation. As the alpha grows, the hardening effect becomes less pronounced,

and finally, when the alloy is entirely overaged, the properties approach those of a fully annealed alloy—in the sense that strength is lowest and ductility highest. Thus, the commercial heat treatment for the Complex would be an overaging process. The stronger and less ductile condition would be produced by a minimum of overaging, as contrasted to the more ductile state which would result from complete overaging.

The relationship between strength and ductility for the 3Mn-Complex titanium alloy is shown in Fig. 1. These measurements were made on material hot rolled at 1,450 F, solution treated at 1,300-1,400 F, and aged at different times and temperatures to produce the indicated strength level.

The effect of the rolling temperature is also shown as a strength-ductility relationship. Rolling the Complex alloy at temperatures in excess of 1,450 F is undesirable, since the position of the strength-ductility curve is lowered considerably. The loss in tensile and bend ductility of many titanium alloys when heat treated or rolled above about 1,500 F is as yet unexplicable, although many theories have been advanced. Table II lists values of strength and ductility for two heat treat schedules.

The impact properties of the 3Mn are excellent, a notable contrast to most titanium alloys. After overaging to the 140,000 psi ultimate strength level, the new alloy exhibits impact strengths of between 25 to 30 ft-lb in the standard Charpy "V" notch test.

Thermal stability tests reveal the new alloy is as stable as any commercial alloy at any strength level up to 180,000 psi. These tests were based on the change in room temperature mechanical properties (strength and ductility) in the as-heat-treated condition, after stabilizing for long periods at different temperatures. At a strength level of 215,000 psi, no noticeable change in mechanical properties occurred after exposure for 1,000 hr at 350 F or 500 hr at 500 F. However, at the latter temperature, there was a marked decrease in elongation after 1,000 hours. At lower strength levels, such as 170,000 psi, the alloy is stable for 1,000 hr to at least 650 Fahrenheit.

Fabrication

As is typical of most titanium alloys, the 3Mn material has a slight deficiency in sheet ductility, but this is believed to result from variations in processing from the ingot to the sheet. The adoption of proper rolling techniques should, by and large, remove this deficiency. "In the mill" tests by Mallory-Sharon have shown the feasibility of this alloy as a promising high strength sheet material.

Considerable time has also been devoted to evaluating the forgeability of the new alloy. The Wyman-Gordon Company has successfully forged gear blanks, Fig. 2, by heating at 1,750 F for one hour and forging without reheating in two operations; finishing temperature was approximately 1,500 F. Die fill was reported as excellent, and there was no evidence of cracking. Although this new alloy seems to forge "harder" than steel, the fact that the forging temperatures used were several hundred degrees lower than those normally used for steel indicates that the material can be forged on a commercial basis.

After pickling and descaling, the experimental gear blanks were checked for response to heat treatment. This was determined by comparing sections of the heat treated forgings with heat treated bar stock. These comparisons showed the ductility of the heat treated forging to be slightly less than that of the bar stock; but this loss is not significant enough to detract from the importance of the Complex as a forging alloy which can be heat treated through a spectrum of strength-ductility values. Another result of these tests was that there is some variation in properties, depending on the position of the section in the forging proper.

Machining is no problem with the 3Mn alloy. Machinists at the Wright Air Development Center say the material handles much as do the common stainless steels. For milling and sawing, best results are obtained by using slow cutting speeds, heavy feeds and a carbon tetrachloride-base lubricant.

Future Possibilities

Even though the Complex has not been marketed officially in production lots, it will have numerous uses as an alloy of titanium that will help bridge the strength gap between steel and the common non-ferrous alloys such as aluminum. In general, it will probably be used where high strength sheet and high strength bar stock or billet material is needed.

As mentioned previously, this alloy lends itself well to forging and subsequent heat treatment. This suggests uses such as flywheels, turbine compressor disks, pulleys, gear blanks and structural members. In aircraft, the substitution of high-strength titanium alloy bolts for steel bolts would result in appreciable weight savings.

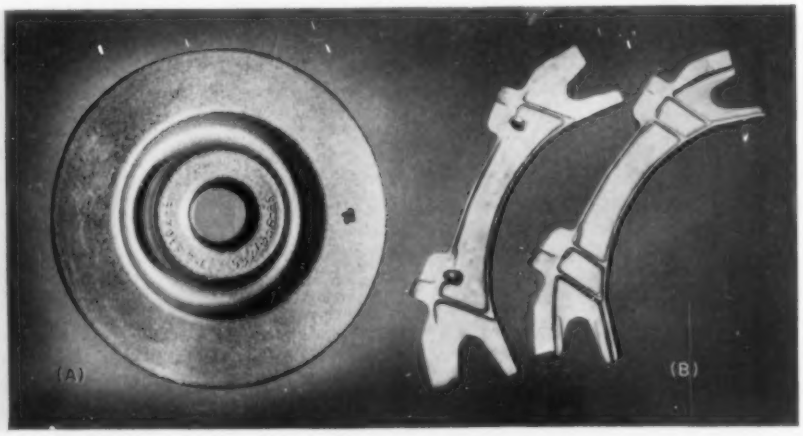

Fig. 2—Experimental parts forged from 3Mn-Complex titanium. Gear blank (A) was forged at 1,750 F; aircraft part (B) was produced by the Mallory-Sharon Titanium Corporation.

Automatic Balancing Of Rotating Masses

A new principle of hydro dynamics and its application in the design of a balancing system that uses fluid as the balancing medium. Current applications include several rotating types of hydroextrators and spin drying machines.

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METHODS FOR REDUCING the effects of unbalance in a rotating machine can be divided into two classes. The first includes those methods in which the vibration is reduced without reducing the unbalance. For example, rubber mountings, spring suspensions, and increasing the mass of machine components.

In the second group are balancing mechanisms like the Leblanc Balancer, Ring Balancer, Ball Balancer, and the Pendulum Balancer. The possibilities and limitations of each of these are known. However, none of them satisfies all the requirements of the ideal balancer which are:

(1) Correct the unbalance completely;

(2) Be effective at speeds both below and above critical;

(3) Automatically adjust for variations of the amount of unbalance;

(4) Correct the unbalance in the plane of the unbalance.

The Duncan fluid balancer* which is described in this article illustrates a principle that satisfies the first three requirements exactly, and the fourth very closely.

If a vessel containing a fluid is rotating about an axis passing through its center of gravity, the centrifugal force acting on a particle of volume, dV is:

$$df = \rho\, dV \omega^2 r \qquad (1)$$

where

ρ = fluid density
ω = angular velocity, and
r = distance from axis

Since

$$dV = r d\alpha\, dr\, dh,$$

the increase in pressure created by the particle acting on a surface of area $r\, d\alpha$ dh is:

$$dp = \frac{df}{r\, d\alpha\, dh} = \rho \omega^2 r\, dr \qquad (2)$$

Therefore, at distance r, and at a given depth from the surface the pressure is:

$$P = \int_{r_o}^{r} \rho \omega^2 r\, dr \qquad (3)$$

Assuming the fluid to be incompressible, and the angular velocity constant,

$$P = \frac{\rho}{2} \omega^2 (r^2 - r_o^2) \qquad (4)$$

where r_o is the distance from the axis to the particle of fluid which is nearest to it.

The pressure due to gravity and variations in pressure due to differences in depth can be neglected for most practical problems.

It is now imagined that while the vessel and fluid are rotating at constant speed, a portion of liquid of mass, L, is isolated from the rest of the liquid by a rigid wall with no thickness and no mass. For simplicity, the shape of the isolated mass is taken as cylindrical with diameter D and height b and with its axis parallel to the axis of rotation and totally surrounded by the liquid, Fig. 1. Obviously, this does not disturb the equilibrium of forces and the values of pressure. The forces acting on the outside of the cylindrical shell are balanced by the forces inside the shell. The forces generated by the mass inside the shell are:

(1) An internal pressure due to the rotation. This bursting force is symmetrical about the axis of the cylinder and does not have any component which would tend to displace the cylinder.

(2) A centrifugal force directed radially from the axis of rotation tending to displace the cylinder, equal to $Lr\omega^2$ and applied at the center of the shell.

The forces acting on the outside of the cylinders must balance the forces from the inside and can be divided similarly into two parts.

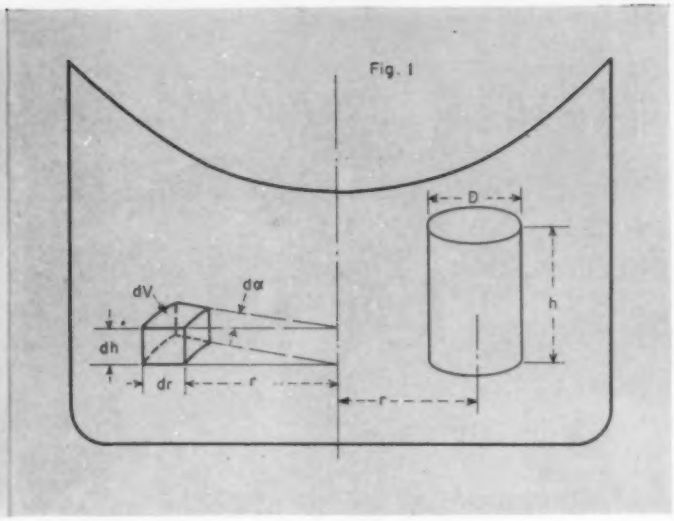
One which opposes the bursting of the cylinder and has no component tending to displace the cylinder.

The other, which equalizes the

* *Pat. Applied for*

Fig. 1—Rotating vessel filled with fluid. Isolated cylindrical element is used to illustrate the theory of this new principle of balancing.

Fig. 2—Shell in (A) with center at C, represents a body of non-uniform density immersed in large cylinder such that the centers of gravity of the two bodies do not coincide. In (B), a shell of equal volume is isolated from the fluid opposite to the original shell to show how the center of gravity of a system will coincide with the axis of rotation.



centrifugal force and prevents the displacement of the cylinder, must be equal and opposite to $Lr\omega^2$ applied to the center of the shell.

If the liquid is now removed from the cylinder and replaced with a lighter fluid, of mass M, the forces acting on the outside are unchanged. The forces acting on the inside, however, have changed. The bursting force has been reduced in proportion to the density of the lighter fluid, the excess pressure exerted from the outside being resisted by the shell.

The centrifugal forces also have been reduced in proportion to the lighter mass, the pressure from the outside remaining the same. The difference between the two causes the shell to move toward the center:

$$F = (L - M)\omega^2 r \qquad (5)$$

When the cylinder is filled with the lighter fluid it will be subjected also to an upward force $(L—M)$ according to Archimedes principle. Thus, the shell will move up and towards the center. If it reaches the surface and floats, the mass of the heavier fluid displaced equals the mass of the liquid in the cylinder, or $L = M$. From Eq (5), when $L = M$ the force pushing the cylinder towards the center becomes zero.

From this, Archimedes' principle can be extended as follows: *If a body is immersed in a rotating fluid, there is a force on it acting toward the center of rotation, proportional to the mass of the fluid displaced, the radius and the square of the angular velocity.*

This principle is not limited to cylindrical shells but can be applied to any other shape provided that the content of the shell is uniform and the center of gravity of the enclosed material coincides with the geometric center of the shell itself.

Thus, *if a body of uniform density which would float freely on the surface of a rotating fluid is kept immersed in the fluid by means of an external force, it will center itself on the rotating axis.*

Now, consider a body of non-uniform density immersed in a rotating fluid, for example, a round shell containing a mass M whose center of gravity does not coincide with the center of figure of the cylinder, Fig. 2.

From the considerations made previously, the outer fluid exerts a force towards the center of magnitude $L\omega^2 p$ and which acts as if it were applied at C the center of the shell.

The centrifugal force acting on mass M is $M\omega^2 q$, where q is the distance from G, the cg of M, to the axis of rotation. This force can be taken as applied at G. The two forces $L\omega^2 p$ and $M\omega^2 q$ create a couple, and if the cylindrical shell has sufficient freedom of movement the 3 points O, C and G eventually will be in line—the forces acting on the cylinder being: $L\omega^2 p$ directed towards the center and $M\omega^2 (p + e)$ directed away from the center.

The cylinder will move radially and will find its position of equilibrium when $L\omega^2 p = M\omega^2 (p + e)$, that is, when

$$p = \frac{Me}{L - M} \qquad (6)$$

Also,

p is positive when $L > M$ (body lighter than liquid displaced.)
$p = \infty$ when $L = M$ (body freely floating)
p is negative when $L < M$. (Body heavier than liquid displaced.)
$p = 0$ if $e = 0$
p is independent of angular velocity.

When the cylinder has reached its position of equilibrium, the center of gravity of the total mass, i.e., fluid and mass of the cylinder, can be located in the following manner:

Isolate from the mass of the fluid a portion equal in shape and volume to the cylindrical shell, but opposite to it at a distance p from the center, Fig. 2(B). The cg of all the liquid outside these areas coincides with the center of the vessel. The cg of the cylindrical shell with mass M and of the isolated liquid of mass L is obtained by taking moments about any line perpendicular to diameter dd Thus,

$$L(d - p) + M(d + p + e) = (L + M)x,$$

$$x = \frac{(L + M)d + (M - L)p + Me}{L + M}$$

Writing for p its value from Eq (6), the result is $x = d$.

This shows that the center of gravity coincides with the axis.

As before, this analysis is not limited to cylindrical shells but can be adapted to any size or shape. There-

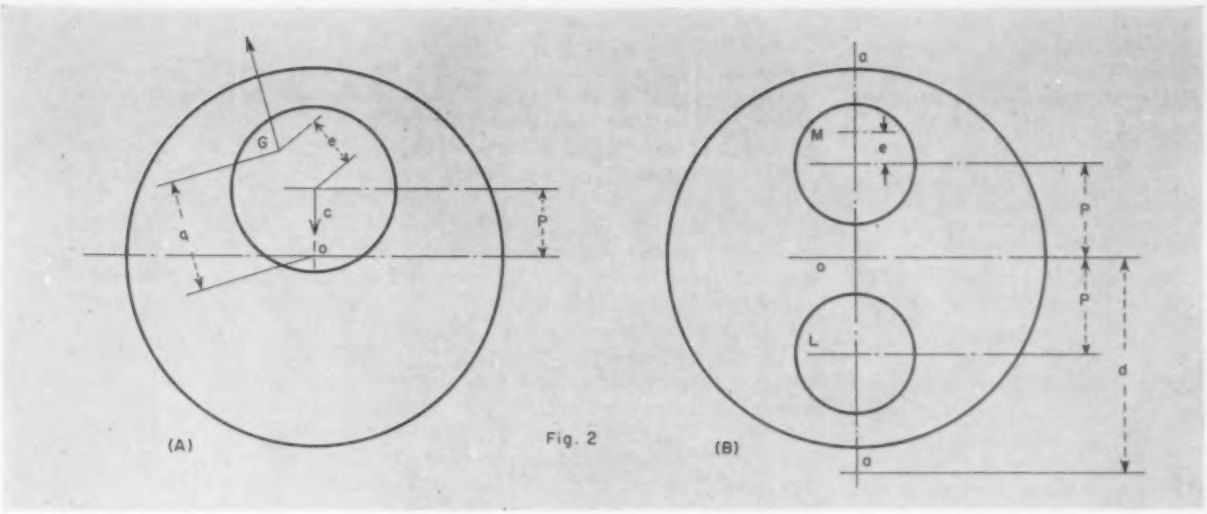


Fig. 2

fore, the following generalization is possible:

When a body of nonuniform density which would float freely on the surface of a fluid contained in a rotating vessel is kept immersed by means of an external force, the body automatically takes a position such that the center of gravity of the system comprising the total fluid and the body coincides with the axis of rotation.

To obtain perfect balancing in a rotating machine it is enough to place the mass out of balance in a container immersed in a heavier fluid and keep it immersed. In practice, this is realized by having the unbalanced mass immersed in a ring of fluid with no fluid underneath which would push the mass upward. In this way, the weight of the unbalanced mass keeps itself immersed in the ring of fluid. Alternatively, if the mass were completely surrounded by fluid it would have to be kept immersed by preventing upward movement mechanically.

It is noteworthy that the magnitude of the balancing force is not determined by the amount of fluid present in the machine but by the amount of fluid displaced.

EXAMPLE:

Consider the design of a simple spin drying machine as shown in Fig. 3, in which container *C* is mounted on shaft *S*. The basket *B* contains the unbalanced mass *m* and has an annular chamber *f* which is sealed and acts as a float.

When the system is rotating, the fluid takes the shape of a ring around the basket. According to Eq (5) the force acting on the basket is $(L - M)\omega^2 r$ where L, the mass of the

volume of displaced fluid $= \rho \frac{\pi}{4} d^2 h$.

M is the total unbalanced mass, that is the mass of the load plus the mass of the basket.

The maximum displacement of the basket is proportional to the maximum unbalance which can be measured.

$$P_{max} = \frac{Me_{max}}{L - M}$$

The diameter D of the container must be at least equal to $(d + 2P_{max})$,

or $$D \geq d + \frac{2Me_{max}}{\frac{\pi}{4} \rho d^2 h - M}$$

This shows the influence of the di-

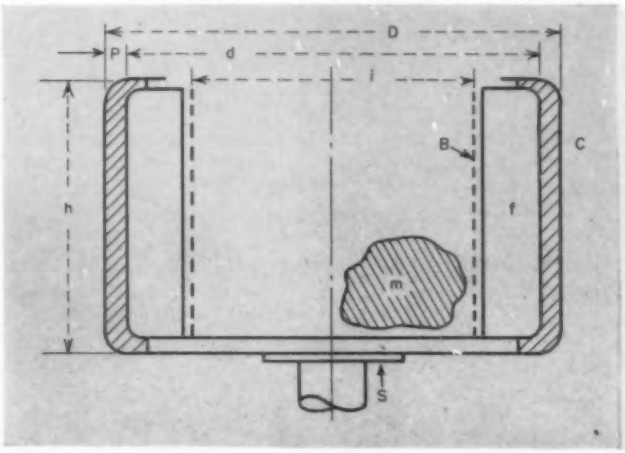


Fig. 3—Simple spin drying machine. Using the principles of this new system, 17.5 lb of mercury or 35 lb of water will correct an unbalance of 90 lb-in. The basket does not require precise balancing; components are simple and balancing is automatically correct for any unbalance up to the 90 lb-in. capacity. Only parts that require careful balancing are the container and shaft. Limitation is that weight of basket plus load must be less than weight of fluid displaced.

ameter of the basket and of the density of the fluid on the overall size of the machine.

Using the following numerical data:

$d_t = 16$ in.
$d = 22$ in.
$h = 12$ in.
Basket = 50 lb, Load = 30 lb
Off-center of load = 3 in.
Unbalance = 90 lb-in.
Since water denstv is 0.0362 lb/in.^{3}

$$L = (0.0362)\left(\frac{\pi}{4}\right)(22^2)(12) = 160 \text{ lb}$$

$$P_{max} = \frac{90}{160 - 80} = 1.1 \text{ in.}$$

The diameter of the container must be

$$22 + (2 \times 1.1) = 24.2 \text{ in.}$$

The volume of water required in the system is that of the annular space between container and basket, neglecting the small quantity above and below the basket.

Thus,

$$V = \frac{\pi}{4}(24.2^2 - 22^2)(12) = 960 \text{ in.}^3$$

which weighs 35 lb. Using mercury instead of water, L would be 13.6 times greater and therefore:

$$P_{max} = \frac{90}{(160 \times 13.6) - 80} = 0.043 \text{ in.}$$

The diameter of the container in this case would be 22.086 in. and the weight of the mercury required to fill the annular space would be 17.5 lbs.

The balancing is perfect and agrees with the theory if the basket rotates at the same speed as the fluid and the basket is free to move sideways to any position to which the fluid pushes it. If friction hinders the free movement of the basket there will be a time lag before the friction is overcome and balancing is obtained.

If the basket does not rotate at the same speed of the fluid the balance cannot be perfect. But since the balancing is independent of the angular velocity, the basket can rotate at a lower or higher speed than the speed of the outer container. All that is required is that the basket and the fluid next to it rotate at the same speed, and about the axis of the container. The speed of the rest of the fluid does not affect the balance of the machine. It would be possible to design a machine with basket and fluid rotating but with the outer container stationary.

For large machines, where the masses involved are large, it may not be advisable to rely on the friction of the fluid to drive the basket, not because it may take too long a time for the basket to reach the desired speed, but the balancing would take place at low speeds.

There are several possible ways to drive the basket and allow for the required amount of lateral displacement. Of the various mechanical ways, the simplest and very suitable is to drive by means of a double slide at right angles.

The critical speed of the system offers some interesting considerations. The mass of the basket and of the balancing fluid will always rotate about the true axis in spite of any deformation of the shaft or container. The critical speed of the system should be calculated disregarding the mass of the load, basket and balancing fluid. Only the mass of the container, shaft, pulleys and motor should be taken into consideration. This fact will raise the value of the critical speed in most cases beyond the operational limits.

The correction of the unbalance takes place by action of the fluid pressure on the outer surface of the basket. The resultant of all these forces acts as if it were applied to the center of gravity of the fluid which has been displaced.

The forces due to the unbalance are applied to the center of gravity of the basket and load. The designer of a machine using this fluid balancer should try to proportion the basket in such a way that its center of gravity will be very close to the geometric center, and should also take in consideration the fact that the load is at the bottom of the basket. However, the distance between the planes of the balancing and unbalancing forces cannot be very great.

ENGINE STANDARDIZATION PAYS OFF

THE U. S. ARMY CORPS of Engineers recently announced some results that they have obtained from a program to standardize the industrial gasoline engines used by the Army, Navy, and Air Force. This program, initiated in 1948 as a result of the complicated maintenance and supply problems caused by the use of 339 different makes of engines during World War II, includes the standardization of engine high mortality parts and accessories, small industrial engines, and the test and evaluation of industrial gas turbines.

The program of standardizing the high mortality parts is being accomplished within the limits of available machine tooling and current engine design. Under it, maximum interchangeability of parts is being achieved. Completion of this phase of the program, which covers pistons, rings, valves, and bearings, will ultimately reduce to 165 military standard parts the 1827 parts now required to maintain gasoline engines within the 2⅛ through 6 inches cylinder bore range.

Development work in the most popular bore sizes, 3 through 4 inches, has been completed and modified engines are being procured. The parts to support the 138 models manufactured in this range have already been reduced from 1187 different non-interchangeable parts to 59 interchangeable parts.

Modified standardized engines in the 4 through 5 in. bore sizes will soon be obtained, and standardizing the high mortality parts of the engines in the 5 through 6 in., and 2 through 3 in. will be completed by this summer. The result will be a great reduction in the stocks of spare parts in the supply system, and a greater efficiency and productivity in tooling, manufacturing, cataloging, storing, and issuing.

The small industrial engine standardization program was also instituted as a result of the experience gained during World War II which showed how field conditions, and military fuels and lubricants effected the operation of engines smaller than 20 horsepower. The ultimate goal is the reduction of makes and models in this range from 78 to 7, all having long life, small size, and light weight features, simplicity of maintenance, and adaptability to quantity production.

Six Basic Servo Control Systems

How to Improve Their Response

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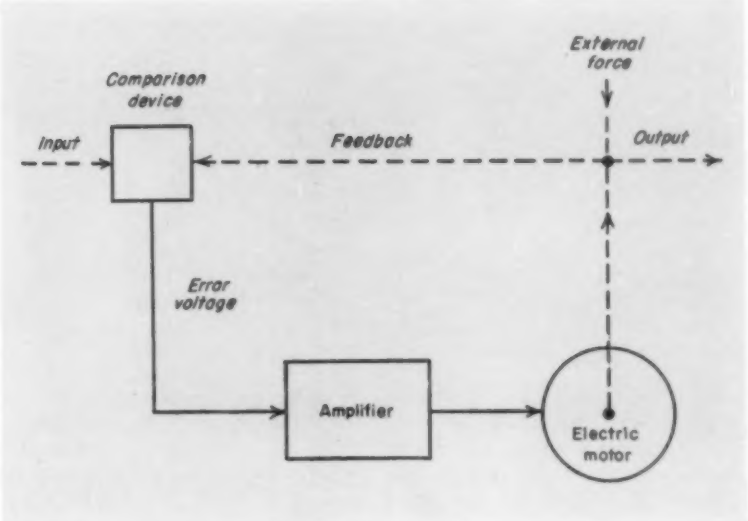
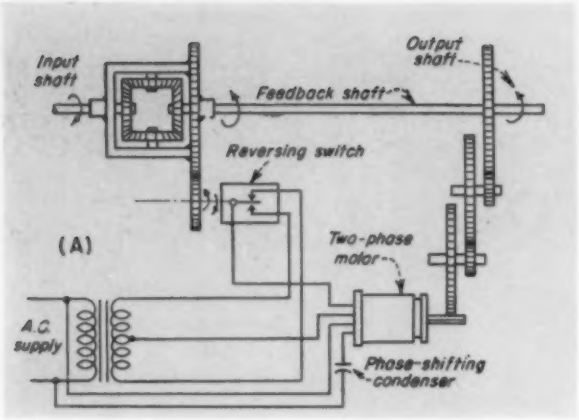
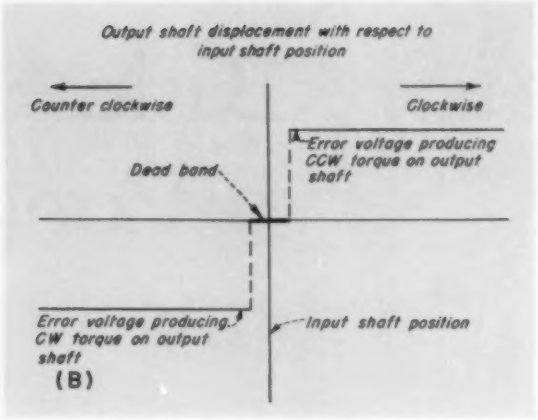
THE MOST COMMON TYPE of servomechanism consists of an electromechanical system which continuously compares the output with the input and uses the difference to correct the output. These systems are used when an instrument must be read remotely or when a large load must be controlled by a weak electrical signal or a low power mechanical motion. Typical examples might be an electromechanical follower system that causes the tool of a copying machine to follow the contour of a master template, or a remote temperature indicator in which a servo positions the indicating pointer in accordance with the resistance variation of a thermistor. Thus, all servos control an output in accordance with variations in an input. The controlled output can be temperature, resistance, velocity, position or any other measureable variable. Often a servo loop is used to control one variable as some function of another variable. In this application, transducers are required.

Servo loops can be divided into the two classes: The on-off servo which senses the direction of the error but not the magnitude, and the proportional servo which senses both the direction and magnitude of the error. On-off electromechanical servos can consist of a reversing relay actuating a reversible motor, or a unidirectional motor driving two clutches to obtain the reversing action. Proportional electromechanical servos may use inductive devices, such as inductive pickoffs or synchros, or bridge type sensing units. The following material includes schematic diagrams outlining the operation of these basic types of electromechanical servos together with methods of improving the static and dynamic response by the addition of some type of rate or integral control.



1. *Basic electromechanical servo loop.* This type of system is used to position the output in accordance with the input. Usually the input and output are mechanical with the output being driven by an electric motor. The input and output are compared and the difference or error is amplified and used to drive the motor. The polarity or phase of the error voltage indicates the sense of the error. When output position equals input position the system is balanced and the error is zero. In addition to changing position as a result of changes in input position, the output can also be driven from balance by external disturbances. This produces an error voltage that will energize the drive motor to rebalance the system.

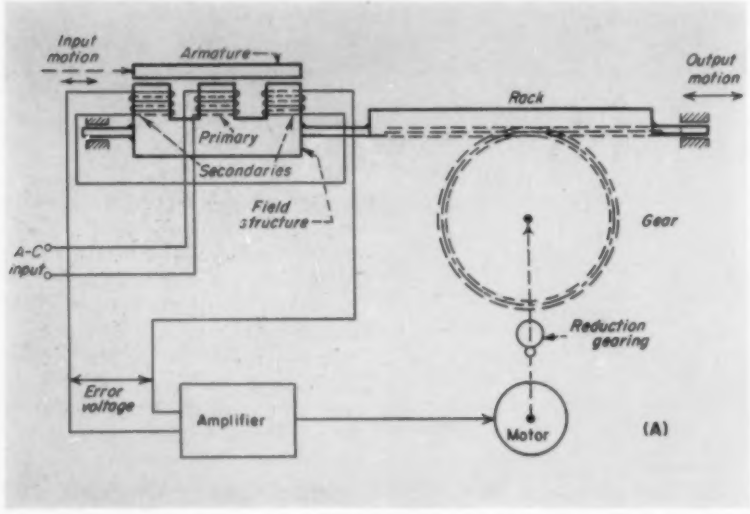


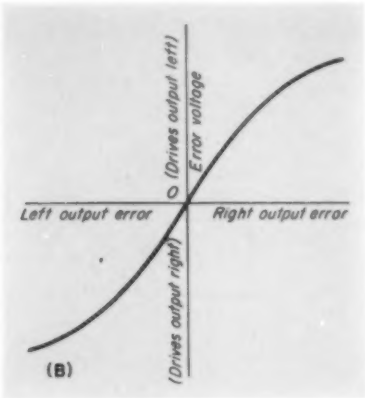

Output shaft displacement with respect to input shaft position
Counter clockwise
Clockwise
Error voltage producing CCW torque on output shaft
Dead band
Error voltage producing CW torque on output shaft
Input shaft position
(B)

2. *On-off servo with mechanical feedback.* This is the simplest type of servo based on the system shown in 1. The input and feedback (output position) are used to actuate the coaxial shafts of a mechanical differential, while differential casing rotation drives a double-throw reversing switch through gearing. A difference (or error) between input and output position will drive the differential casing in a direction to close one or the other of the switch contracts. This will energize the motor in the proper manner to drive the output shaft into correspondence with the input shaft. With this type of relay servo there will be some angular motion of the output shaft, called the dead band, during which neither side of the switch is closed. The curve in (B) shows the variation in error voltage when the output moves from one side of the input to the other.

Since the motor must be capable of being reversed while running, splitfield d-c or two-phase a-c induction motors are used. If motor power consumption is too heavy for the switch contacts, intermediate relays can be used for power amplification.

A simple system such as this can only be used where the input changes slowly and the dead band inaccuracy can be tolerated. The principal drawback is that the error voltage remains at its full value until the output almost reaches the correct position. Output inertia will then cause an overshoot, closing the other side of the switch. This results in the output being driven back at full power and the system will be unstable and will hunt unless there is sufficient friction to dissipate the kinetic energy. The system can be made stable by enlarging the dead band so that the output cannot coast through it; however, the static error increases since the output can stop anywhere in the dead band.



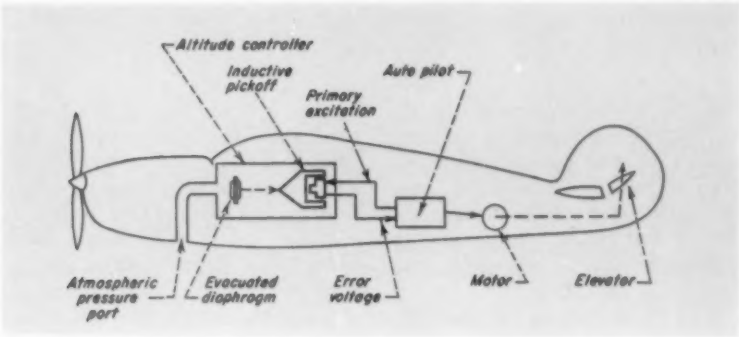


3. *Inductive servo system.* Here the switch of 2 is replaced by an inductive pickoff. This arrangement has the advantage that the error voltage decreases gradually as the output approaches the balance point in contrast to the on-off servo where the error voltage changes abruptly. The pickoff consists of an armature and a field structure. A primary coil (connected to an a-c power source) is wound on the middle leg of the field laminations while two secondary coils (connected in series opposition) are wound on the outer legs. When the armature is in a

balanced position relative to the field, the voltages induced in the secondary coils are equal and opposite and effectively cancel out. The minimum output voltage obtained under this condition is called the null. When the armature is out of balance, the magnetic coupling to one secondary coil is greater, causing a net error voltage with a phase depending on the direction of unbalance. The error voltage will increase with armature movement until a mechanical limit or point of greatest coupling is reached. Curve (B) shows the variation of error voltage with armature displacement.

For the system shown here, a change in input position unbalances the pickoff and generates an error voltage with the proper phase and a magnitude depending on the amount of unbalance. This error voltage is amplified and used to drive the motor in the direction to bring the output into alignment with the input and rebalance the pickoff. With the gradual change in error voltage, the output will slow down enough so that it will stop when the null is reached if the load does not coast too easily. In the event of an overshoot, the kinetic energy to be absorbed will be less than that in the system with the switch, and the oscillations will damp out more rapidly.

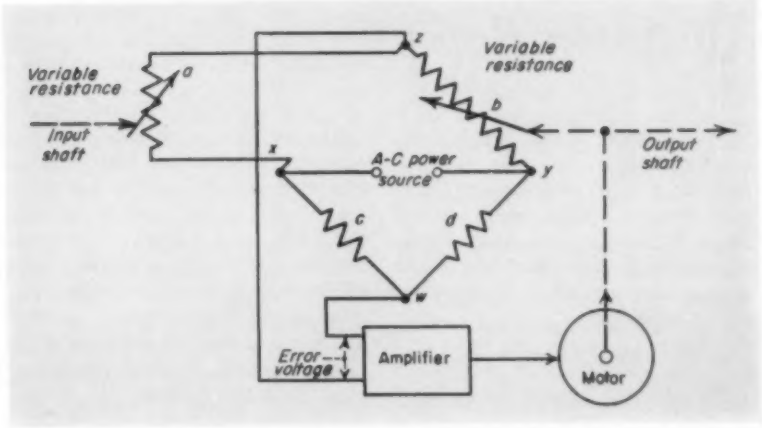
As in the previous system, either split-field d-c or two-phase induction motors can be used, with the a-c type being favored because of the advantages of a-c amplification. In low power servos, the amplifiers may be all electronic or a combination of electronic and magnetic.



4. *Inductive system with indirect feedback.* While the previous systems have direct merchanical feedback, some servos such as this airplane altitude controller close the feedback loop indirectly. An evacuated diaphragm, sensitive to atmospheric pressure, is used to actuate the armature of an inductive pickoff. The error signal from the pickoff is amplified in the autopilot and drives a motor which positions the elevator flaps to regulate the climb or descent of the plane. The reference pressure at which the pickoff is balanced can be adjusted by moving the field structure by means of an external setting shaft.

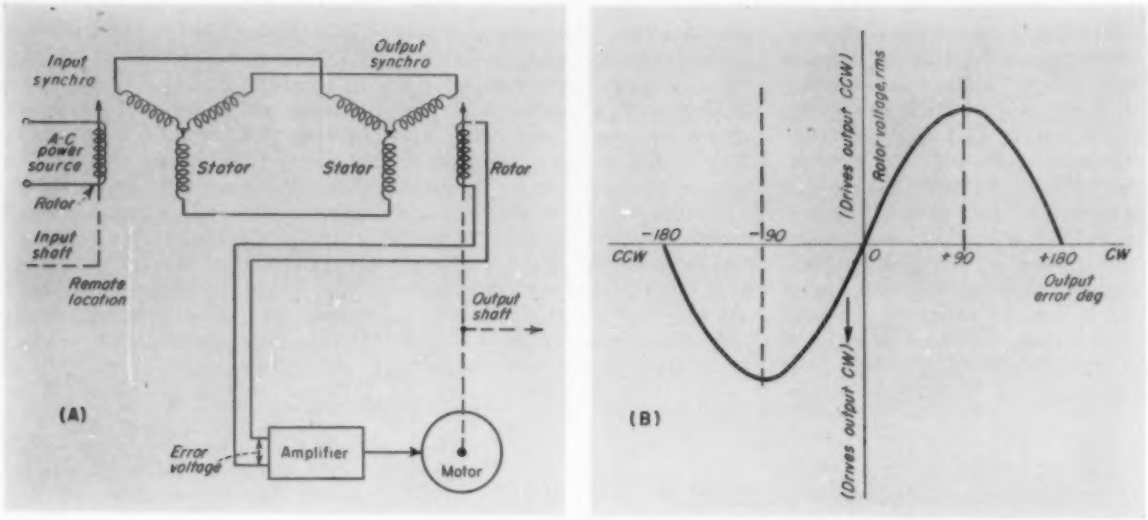
If outside air pressure is admitted to the actuating diaphragm, the error signal from the inductive pickoff indicates changes in airplane altitude from the reference level established by the field structure setting. The elevators return the airplane to the correct reference altitude and the pickoff balances at null. In this loop, feedback depends on the response of the airplane to the elevators and on the variation of air pressure with altitude.

Error signals can be caused by the operator turning the setting shaft to select a new altitude, or by the airplane changing altitude as a result of unsteady air currents. The latter is an example of an external disturbance.



5. *Remote servo using bridge-balancing network.* This system is based on a four-legged bridge. The input shaft is connected to a variable resistance *a*, and the motor and output shaft are connected to variable resistance *b*. For a balanced condition the ratio of resistance *a* to resistance *b* is equal to the ratio of *c* to *d*. If the input shaft is moved to unbalance the bridge, an error voltage will be developed across points *z* and *w*. This signal is amplified and drives the motor to rebalance the bridge by properly adjusting resistance *b*. Thus the output shaft is positioned in accordance with the position of the input shaft.

A bridge system can be used to advantage if the desired measurement can be made directly as a resistance. That is, if variation of an input quantity (not a shaft motion) can be made to change a resistance, such change can produce an output shaft motion. For example, a resistance thermometer can be connected at *a* in the bridge circuit. The output shaft can then be used to position a temperature indicator or to actuate a temperature control system. A similar type of servo can be used with a capacitance bridge instead of a resistance bridge.



6. *Remote servo using synchro transmission.* A synchro is a particular type of inductive pickoff which transmits an electrical signal proportional to angular position. No mechanical connection is required so that synchro transmissions are useful for remote indication. A synchro looks like a motor and has a single-phase rotor winding and a three-phase, Y-connected stator winding.

In the system shown here the current in the input rotor winding produces a radial flux whose direction depends on the angular position of the rotor. This flux induces a voltage in each of the three stator windings, with the relative magnitude of the stator voltages depending on the angle between the rotor and stator windings. Every angular position of the rotor produces a ratio of the three stator voltages that cannot be duplicated by putting the rotor in any other position.

Since the stators of the two synchros are connected together, each voltage is impressed on the corresponding phase of the output synchro. These voltages combine to produce a resultant radial flux in the same direction as the rotor flux in the input synchro. The variation in output rotor voltage as the rotor of the output synchro is turned through one revolution while the input rotor is held fixed is shown in (B). Between the dotted lines, the error voltage increases with angular error. This voltage is amplified and used to drive a servo motor which brings the output into angular correspondence with the input.

When the output rotor is moved more than 90 deg from the null, the error voltage again decreases and falls to zero at 180 deg. However, when the rotor is slightly off 180 deg, the error voltage is still of the right phase to drive the output to the true null. Because the error voltage at this point is low, the motor torque is small.

Servo System Response

In the basic systems shown here the only information available to the motor is the position or displacement of the output with respect to the input. In the on-off servo, the motor only knows which side of the null it is on but not how far. In the other systems, the motor knows it is approaching the null because the error voltage decreases; however, the only thing the system can do to take advantage of this knowledge is to reduce the torque on the motor. Only the friction of the system opposes the inertia of the load so that if the friction is not great enough, the system will coast past the null. One way to prevent this is to reduce motor power, and thus the speed with which the motor drives the load for a given displacement; however, this causes the system to respond slowly to changes in the input. By the addition of compensating devices and networks the response of these systems can be improved.

Rate Control

If a servo could adjust the speed of the motor in accordance with its distance from the null, the output would approach rapidly and as it neared the null would slow down and stop. This can be done by coupling a generator to the servo motor.

The rate voltage obtained from the generator is combined with the displacement error voltage so that when the motor is moving towards the null, the difference is fed into a high gain amplifier. With high gain a small difference between the rate and displacement error voltages results in full torque on the motor. The direction of the torque depends on the relative magnitude of the two voltages.

When the motor is not at null, the displacement voltage will drive it toward the null at a speed which results in a rate voltage slightly smaller than the displacement voltage. As the motor approaches the null, the displace-

ment voltage will decrease. If the system has a high inertia and low friction the motor will tend to maintain its speed and the output of the rate generator will remain high. If the displacement signal becomes less than the rate signal the phase of the amplified voltage will reverse. The motor torque will then reverse and will oppose the inertia torque so as to slow the motor down to a speed corresponding to the displacement. This will continue until the motor stops at the null. If the rate voltage is insufficient to brake the inertia load to a stop at the null, the system will overshoot once or twice.

Rate voltages can be obtained by using an induction generator in a-c systems, and by using a d-c generator or the rectified output of an induction generator in d-c systems. These generators have the characteristic that voltage output is proportional to speed and the polarity or phase of the output depends on the direction of rotation.

The rate generator damps the system by applying a torque proportional to the motor speed and in the opposite direction.

True Rate Control

The above system of damping is satisfactory as long as the input is stationary. When the input is moving and the output is trying to catch up with it, the motor will slow down as it approaches the null. When motor speed decreases to a point where the output is moving at the same speed as the input, the motor will still be some distance from the null. The faster the input is moving the larger will be this displacement. For the output to catch up with the input, the motor would have to speed up; however, then the rate voltage would exceed the displacement voltage and the reverse torque on the motor would slow it down again. Thus, the motor will lag behind the null by an amount known as the tracking error.

To prevent this tracking error, the rate of change of the displacement error is used instead of a rate signal proportional to the speed of the servo motor. These rates are equivalent when the input is stationary; however, when the input is moving they differ by the speed of the input. The rate of change of error voltage is usually obtained by the use of resistance-capacitance or filter type networks depending on whether the servo operates on d-c or a-c.

The displacement error voltage and its rate of change voltage are combined and fed to an amplifier. If there is a displacement error, the resulting signal will be amplified and will drive the motor to produce a rate of change of error to balance it. When the input is moving and the output in catching up slows down to the same speed, there is still a displacement error. Again the motor speeds up and causes a rate of change (decrease) in that error. Thus, as long as there is a displacement error, the motor will speed up to produce a rate of change signal to balance the error signal. This continues until the output reaches the null.

This is based on the assumption that the error voltage required to produce the tracking speed of the motor is negligible. In practice, some voltage is required, and when the motor reaches tracking speed and the rate of change of error signal drops to zero, the driving voltage can only be produced by a small displacement error. Thus, there is still a tracking error; however, it is much smaller than if a rate generator or no rate signal at all are used.

Also, in actual systems the amplifier saturates when the input signal reaches a certain value and further increases in error voltage do not further increase amplifier output or motor speed. Thus when the output is far from the null, the motor runs at full speed and the rate voltage has no effect.

Mechanical Damping

As an alternative to the use of electrical rate signals, damping torque can be obtained mechanically and applied to oppose the torque produced electrically by the displacement error voltage. If the motor shaft is connected to a fluid damping unit or to a magnetic drag disk, the motion of the motor is opposed by a torque proportional to motor speed. This system is not as flexible as the electrical rate methods, and generally not as much damping effect can be obtained. However, the principal difficulty is that the damping unit imposes a load that must be supplied by the amplifier and motor.

Consequently, in those systems which use this mechanical damping, the designer is faced with a problem. That is, if he wishes to obtain the same system performance as produced by those servos using electrical rate dumping he must necessarily use a larger amplifier and a larger servo motor so as to provide the additional power to overcome the drag produced by the mechanical type damping. This increases the physical size, weight, and cost of the system.

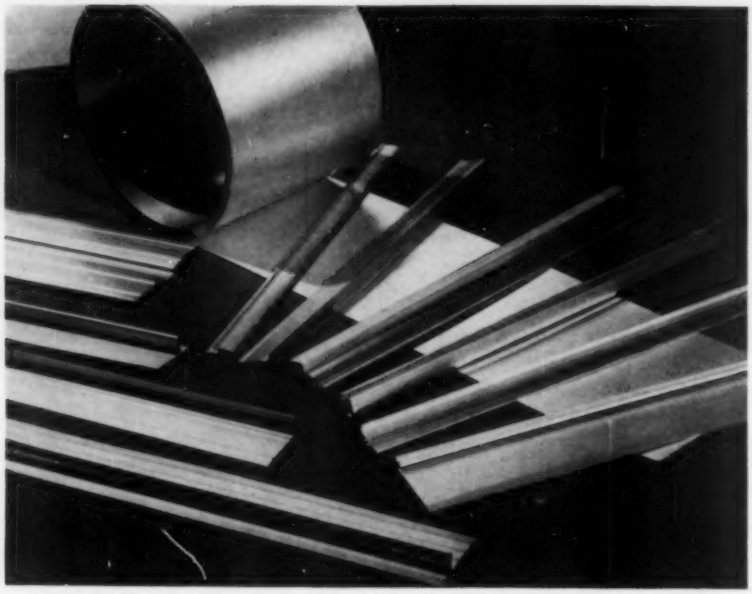
Integral Control

In the displacement servos described here, the error will never stay at exactly zero since there is a small dead band in which the error voltage is too small to drive the motor against the friction load. To counteract this the effect of the remaining error voltage can be accumulated slowly over a period of time until the total is sufficient to move the output towards the null and to further reduce the error. When the motor passes the null, the accumulated error voltage will still be large enough to continue to drive the motor. However, the error voltage will change phase or polarity and subtract from the accumulated voltage. The net voltage will soon change in phase and reverse the motor which will continue to hunt around the null.

When this arrangement, known as time integral control, is used, the hunting is less in magnitude than the error caused by friction, and the output, instead of sitting on one side of the null will have an average position that is correct.

Time integral control can also be used to reduce the tracking error in servos where a rate generator supplies damping. As described previously, when the input in such a system is moving, the output will lag behind it enough so that the displacement voltage will balance the rate generator voltage with just sufficient difference to drive the motor. If displacement voltage only is accumulated over a period of time and the resulting time integral of the voltage is added to the amplifier input, the motor will speed up until it passes the null. The displacement voltage will start to subtract from the integral voltage and the motor will lag again. This process will continue with the output bracketing its correct position by alternately moving faster and slower than the input. The average output is more nearly correct than when the tracking error existed.

TECHNICAL NEWS



SECTIONS OF ALUMINUM WEATHERSTRIP roll formed from alumilite finished coil strip sheet—indicative of the many shapes possible with pre-finished aluminum.

Coated Metal Parts Made Easy——

COATING METAL in the flat and shaping it later is a new development that is making headway in the coated metal products business. According to R. V. Vanderberg of Alcoa's Process Development Laboratories, "This is a growing trend in product finishing, particularly for aluminum products, because fabricators are not required to buy anodizing, electroplating, spray, dip, or roller-coating equipment." Some of the applications for prefinished aluminum include: appliance trim, reflectors, cans and containers, dials, weatherstripping, and the like.

Most forming operations can be performed on prefinished aluminum, including bending, drawing, spinning, stetch-forming, stamping and embossing. However, the degree to which the prefinished material can be formed is dependent on the type and thickness of the coating. Some aluminum alloys coated with a flexible vinyl system can be given as much as a 180 deg bend without damage to the surface. Aluminum coated with a thin anodized aluminum oxide finish will withstand forming without damage to the finish, providing the sheet is not too thick. Actual forming trials should be made to establish sheet dimensions. But if a thick anodic coating is required for maximum protection against abrasion and erosion, forming after application is not feasible. The coating will fracture due to bending stresses at cracks in the oxide layer.

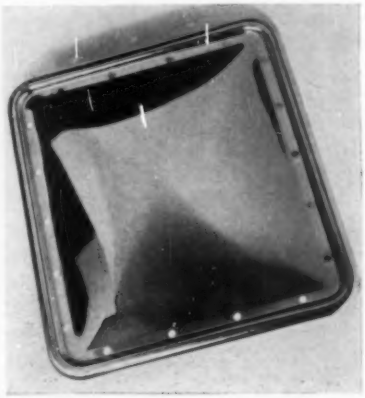
Some Prefinished Aluminum Coatings

Anodized aluminum oxide is an intrinsically hard and brittle protective and decorative coating with excellent resistance to wear and abrasion. As the coating is porous, it can be colored for decorative effect. Although thick oxide coatings may crack when the metal is deformed, they are adherent, and will not flake or peel from the surface. Coating aluminum in the flat with this type of coating is an important factor in simplifying weatherstripping production. The strip cannot be coated easily after roll forming since it is difficult to hold thin sections of various lengths firmly on racks. In present operations, this type of stripping is produced from sheet obtained in 6 or 12 in. widths and in thicknesses from 0.008 to 0.020 inch. Coating is applied, and the strips are slit into proper widths for roll forming.

Paint, lacquer or enamel systems are growing in importance for prefinishing aluminum alloys. Standard painting or roller-coating methods have been used for application of the lacquer or enamel after a suitable wash primer treatment of the metal surface. After the finish is applied in container or can production, for example, the sheets are sheared and formed into the desired shape. To withstand the forming process, special alkyd-resin based finishes are used because of their high degrees of adhesion and flexibility.

Electroplating, by anodic oxidation or disposition of a zinc film on the metal surface, is another prefinishing medium. Bright chrome plating has been deposited on aluminum sheet and formed into deep fryer covers, household appliance trim, and exhaust flues and hoods for kitchen gas ranges.

An important recent development of precoated material is that of copper plated strip. Thin aluminum coil stock which has been given a zinc immersion treatment and copper plated by a continuous process, withstands a roll forming operation which corrugates and bends the material into cable sheathing. The lap joint is then sealed.



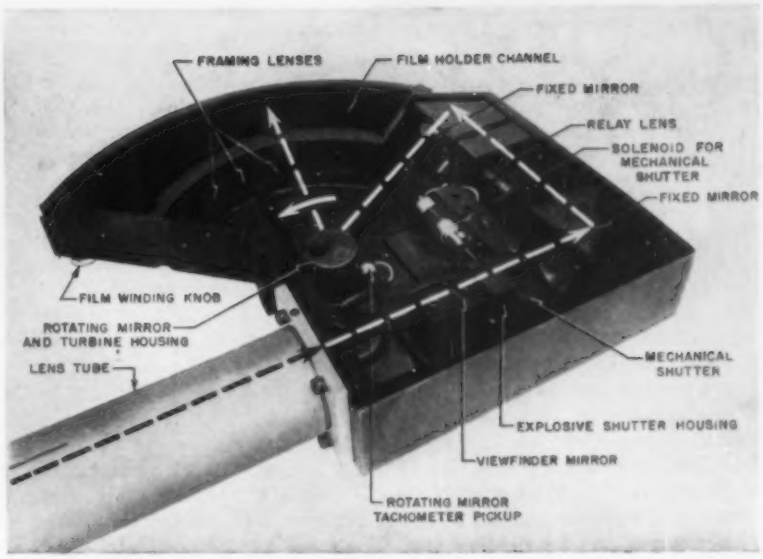
OPERATIONS included stamping and forming on this aluminum chrome plated broiler pan by American Nickleoid Co.

Wants Subsidized Electronics Design Program

"THE SOVIET UNION will forge far ahead of us in electronic control systems unless our government establishes a practical subsidization program for the design and development of electronics to maintain, or perhaps recreate, the leadership we have enjoyed in this field since the end of World War II" . . . so says Louis Fox, Chairman of the Board of Directors of the Aircraft Parts Manufacturers Association of California, and President of the U. S. Relay Co., of Los Angeles.

Fox continued with, "our much publicized developments in the electronics field have created an attitude of complacency in public minds, giving the idea that the United States has a monopoly on inventive genius. This vulnerability is becoming apparent in the inability of the electronic parts manufacturers to keep up with the rapid progress of our aircraft and missile designers, and with the resultant increased demands made upon their products."

Fox also claimed that a few major suppliers are getting the monopoly because they have the money to develop their own ideas in the electronic field.



INTERNAL ARRANGEMENT of the Los Alamos model 8 camera, with the heavy arrows showing the direction of the light rays and the way in which the light beam is swept across the secondary lenses. Used for photographing high speed actions, the camera has a speed of 15,000,000 frames per second.

High Speed Camera Speeded Up

FOR TAKING MOTION PICTURES of explosive phenomena and other high speed actions, the staff of the University of California's Los Alamos Scientific Laboratory has designed a camera capable of attaining speeds of 15,000,000 frames per second, and which will take 96 consecutive pictures of a single event. This camera is an improvement over an earlier model capable of only 3,500,000 frames per second.

Making possible this high speed is a three sided mirror revolving 23,000 times a second, and sweeping a beam of light across a row of lenses to form a series of pictures. The mirror is made of a special steel having a tensile strength of over 300,000 psi, because of the forces tending to explode the revolving mirror. The mirror spins in a helium atmosphere on oil pressure lubricated bearings, and is powered by a small helium driven turbine.

Since the entire strip of film is exposed in about 1/150,000th of a second, no mechanical shutter could be made to close fast enough to prevent the reflected beam from sweeping across the film a second time and double exposing the film. So, an electric detonator was arranged to shatter a glass block in the light path, the shattered block being opaque enough to keep out the light until a mechanical shutter could close.

Housed in a cast aluminum frame, the camera can be easily carried, and be operated by one man. The film used is standard high speed 35 mm, and it is not "souped up."

Airborne Fire Detection System

PROBLEMS OF in-flight fire detection, speed of operation, reliability, automatic resetting, and resistance to physical damage are a thing of the past, according to the Graviner Mfg. Co., Ltd., England, designers of a new system that has successfully passed all flight tests.

Briefly, it is a continuous detector made of a coaxial cable sensitive to fire over its entire length. It requires no additional wiring in the fire zones, since the detector itself is the wire—a stainless steel capillary, containing a temperature sensing material which in turn holds a carefully centered wire carrying an electric current. Resistance of the sensing material diminishes with temperature. The current it will pass is directly related to the temperature it receives. Insertion of a milliammeter in the warning circuit gives information of the mean ambient temperatures under any engine conditions.

Called the Firewire, each end is electrically connected to the warning system. Therefore, the system's monitoring capabilities are not affected by a fracture, unless both ends of the capillary should be simultaneously cut where they connect to the warning circuit. The system requires no vacuum tube amplifiers and no mechanical adjustment.

The Firewire responds within 4 seconds to standard flame conditions; can withstand 1100 F temperature for 6 minutes without deterioration; is unaffected by oil, water, fuel, or hydraulic fluid; and cannot give a false alarm.

What Does a Job-Hunting Engineer Look For?

WITH THE SUPPLY OF ENGINEERS still at a low level, most industrial firms are trying to find the right answer to the question: "What most interests job-seeking engineers?" One such firm, Jack & Heintz, Inc. of Cleveland, Ohio, decided to prepare a new recruitment booklet, and figured that the best answer to the question of "job-seeker interests" lay with its own engineers.

Briefly, here is a cross section of their engineers' thinking on how a prospective engineer forms his "image" of a new company and the opportunities it affords:

I. DEFINING THE TYPE OF ENGINEERING—An engineer approaches a new job much in the same manner he tackles any new project. He first attempts to define the overall limits. Regards a job, he tries to determine the intensity of the work. Is this new job "routine" engineering or "creative" engineering? The answer to this question pretty well sets the degree of challenge and gives the engineer a chance to evaluate his own "fire-enthusiasm-ambition-ability". If he is an easy going man not necessarily seeking frontiers, he will settle for the "routine"; if he thrives on challenge, "creative" will be his choice.

A company, by putting it straight-on-the-line as to the type of engineering involved, can save a lot of interview time and go a long way toward insuring the hiring of the right men.

II. EVALUATES THE COMPANY — The engineer is very anxious to determine the "grade of professional company he will keep". His best means of measurement is the reputation of the firm. He wants an honest statement of where the company stands in its field and some idea of who its customers are.

III. FIXES IMPORTANCE OF THE ENGINEER — The engineer wants to know the degree to which a company's success is due to engineering. By knowing exactly where engineering fits in, the prospect can pretty well deduce management's attitude toward the engineers and the recognition he, personally, may expect. If engineering appears to be just another department, the prospect will conclude that his chances of advancement are limited.

IV. LOOKS AT PRODUCT APPLICATIONS — The engineer pinpoints the field he will serve by looking at product applications. He is not only interested in learning where a product is used, but how important that product is and how many sources of supply there are. The engineer's ultimate objective is to be recognized as "an authority in the field". Generally, he reasons this way: If a product is standard and available from a multitude of sources, his chances are minimized; if the product is constantly changing in design toward higher specifications and is available from only a few sources, his chances are maximum.

V. EXAMINES PRODUCT CLOSELY—An engineer likes to take a look at the "guts" of product. This helps him to realize the types of engineering required to produce the product. This inside look also enables him to project his skills into the product development picture.

VI. SEEKS DETAILS ON JOB CHALLENGES—Aware, generally, of the talents required and the challenges, the engineer is now interested in taking a good close look at some of the specific problems faced in the daily conduct of business. This defines for him the "work load". It also helps him to determine the experience he'll acquire —which to most engineers is of paramount importance.

VII. TRIES TO VISUALIZE ENGINEERING ORGANIZATION — To this point, the engineer has a good, but incomplete, concept of the job. What he seeks now is an integrated picture. His best bet is a case history of a typical project carrying him from initial customer contact through delivery and service. This case history also serves to acquaint him with the degree of interrelation among engineering activities.

VIII. TRIES TO PREDICT PERSONAL PROGRESS — Each engineer is interested in predicting his progress with a new company. Probably the best aid he can be given is a "flow" chart—as close to step by step as possible—which will take him from the day he enters the plant through to final assignment.

IX. SUMMARIZES QUALIFICATIONS —The engineer should be provided with a tabulation of the education, major interests, and experience which would insure maximum success with a company. Every engineer practices the "check-off" method of determining his fitness for a job.

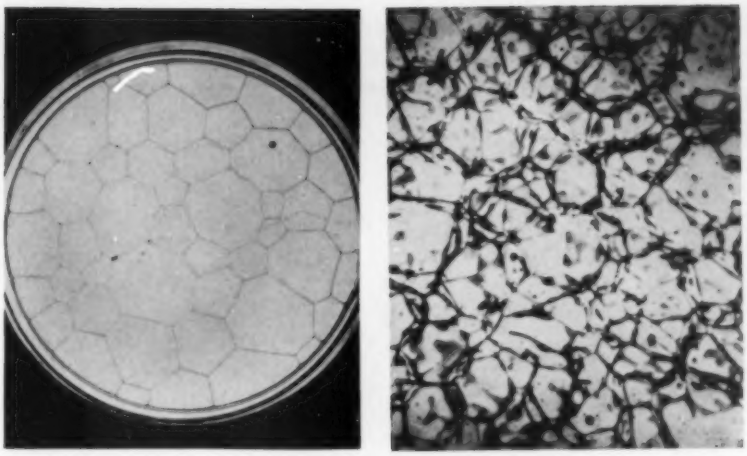
X. INVESTIGATES POSSIBILITY OF ADVANCED SCHOOLING — In connection with the "check-off", an engineer will list whatever deficiencies he might have, and what possibility exists for correcting them. In most cases, additional schooling is the answer. Therefore, the company policy regarding advanced schooling should be made clear.

XI. LOOKS AT SPECIAL COMPANY BENEFITS—Engineers are very interested in a company as "a place to work". He wants to learn all he can about a company's industrial relation programs — health care, insurance, bonus, vacations, and housing.

XII. CHECKS COMMUNITY ENVIRONMENT — Most engineers are or plan to be family men. Because his family depends on the community for spiritual, educational and recreational outlets, the engineer seeks a good cross-section picture of the community he would live in. This is particularly vital to the out-of-towners who may have no idea of the new community.

Progressing through these points, a prospective engineer builds a comprehensive, accurate "image" of a new job and also a fairly decent concept of family life in a new environment.

A company, by giving as much detail as is available, will insure not only getting the type of engineer it seeks, but also an engineer who has seen "all the cards" and is a good bet to stay with the company for some time.



VIEWS OF THE BUBBLE CELLS (left) show how the bubbles grow after the cell has been shaken and allowed to stand for a time. The growth of the bubbles is very similar to the growth of metallic grains in metals (right), which shows a magnified view of an alloy of aluminum and tin.

Soap Bubbles Give Better Metals

STUDIES OF soap-bubbles by scientists in the General Electric's Research Laboratory in Schenectady may aid in the development of metals that are stronger than those now in use, and that have other improved properties. Such bubbles are helping to explain fundamental data on the behavior of metals.

According to Dr. Robert L. Fullman of the Lab., the soap bubbles resemble in many respects the crystals or grains of which all metals are made. In particular, he has found, the way that little bubbles grow into big ones is closely analogous to the growth of metallic grains.

Neither the bubbles nor the grains ever grow by the coalescence of two smaller units into a larger one, he said. Instead, when a bubble or grain gets bigger, its boundaries expand at the expense of adjacent ones which contract and finally disappear.

When the cell, which measures, 5 in. in dia, is filled with a special soap solution, shaken, and then laid on a flat surface, thousands of tiny bubbles appear above the liquid. After it has been allowed to stand ten or fifteen minutes, the bubbles are larger and fewer. At this stage their continued growth may easily be observed. Dr. Fullman has also made lapse-time motion pictures which show the movements speeded up considerably.

The bubbles have varying numbers of sides, but when there are only three sides on a bubble, it starts to disappear. The three sides shrink, while the vapor inside migrates through the walls into adjacent bubbles, which are enlarged accordingly.

In a single metal grain the atoms are lined up like bricks in a wall. So are the atoms in a grain next-door, but the rows in one grain do not line up with those in the other. The line of discontinuity is the boundary between the grains.

When a metal, is heated, some of the grains enlarge, while others shrink and disappear, just as in the soap bubbles. As the boundary of a grain passes an atom, the atom shifts its position a little to get into line with the rows in the expanding crystal.

New Process Suggests Increased Spline Use

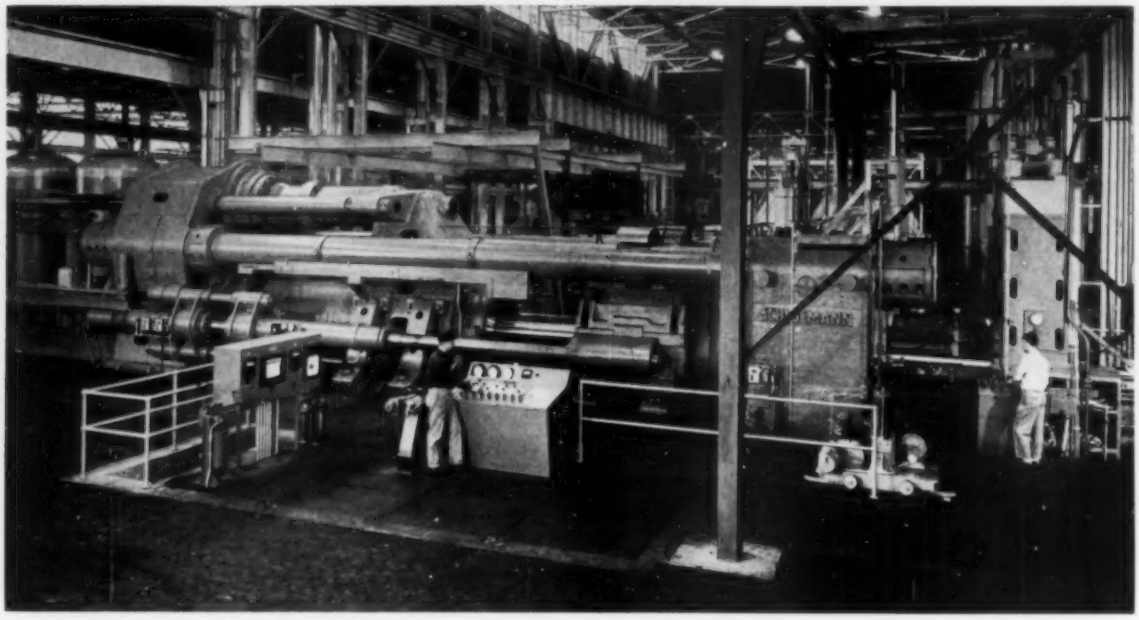
WITH A NEW MACHINE called the Roto-Flo, Michigan Tool Co. has come up with a basically new method for producing splines, oil grooves, serrations, and other similar shapes on external parts. The result is a cold working process in which the metal shaft is placed between two forming racks, and emerges in a few seconds with the teeth formed at any position along the shaft. One of the outstanding features is that the teeth can be formed all the way up to a protruding shoulder, since a recess for tool clearance adjacent to the shoulder is not required. As the metal is displaced and not removed, parts are usually made approximately to the pitch diameter before the forming operation.

Tests have indicated that parts produced with rolled splines will withstand higher torsion loads for equivalent shaft sizes than parts with splines hobbed or shaped from the same material (90,000 in.-lb. vs. 80,000 in.-lb. for the hobbed part).

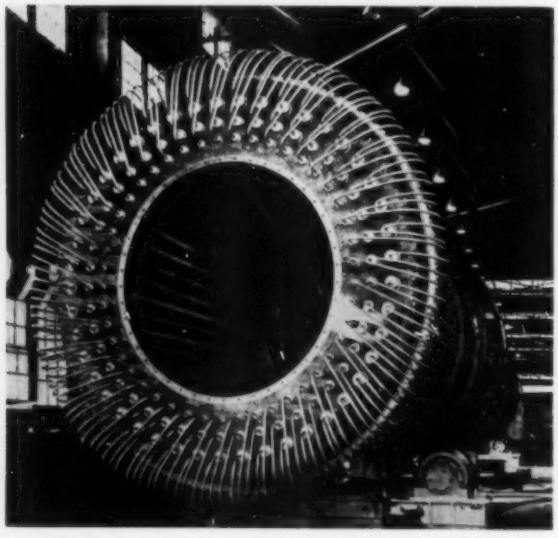
Other features: high accuracy, along with a good surface finish, and a greatly increased production rate. For example: Splined shafts of $1\frac{1}{8}$ in. in dia. and $1\frac{1}{4}$ in. long were formed in 3 seconds; the return stroke, with the machine empty took 2 seconds. Automatic handling of parts will take less than 4 seconds. The parts were rolled from SAE 1037 steel with hardness of 41 Rock. C. The finish was 3 to 6 microinches, and the accuracy within 0.0008 in. variation over 200 parts.

The basic components of the Roto-Flo, besides the rack-type forming tools are two slides and a heavy "C" shaped machine frame. The two slides, holding the forming racks, are mounted one above the other. The slides are geared together with master racks, (not the tool racks) and a connecting gear. The lower rack is the prime mover and is hydraulically powered. The tool racks are adjustable toward the part center to get the proper size, and are also adjustable endwise to get the correct relationship with the part axis. High tool life is expected from the forming racks, since all the stresses are compressive and not in shear with the cutting tools.

THE NEWS IN PICTURES

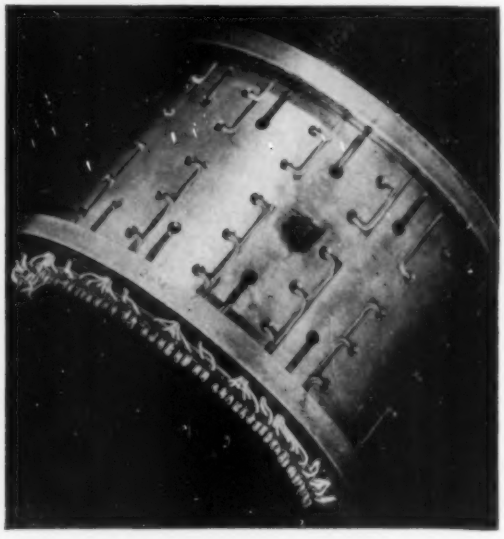


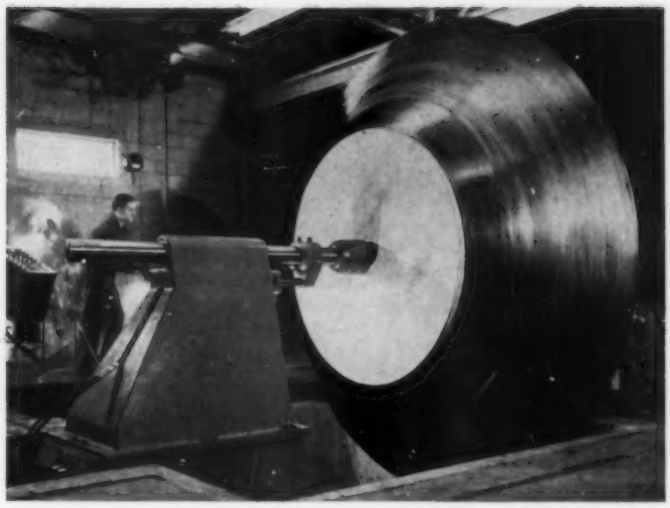
AN OVER-ALL VIEW OF Alcoa's new 14,000 ton extrusion press which has just begun full production. Extruded shapes can now be made in longer lengths (up to 110 feet), with more intricate and greater cross sections, and more weight in a single shape (up to 2,500 pounds). Aluminum pipe up to 20 in. dia. can be extruded. Auxiliary equipment for the press is a 3 million pound stretcher that will straighten extrusions as long as 110 feet and having a cross-sectional area up to 60 sq. inches.



THE FEED END of a huge 100 ft. long, 10 ft. dia. steam tube dryer, one of several made by The General American Transportation Corp. for a chemicals producer. With the exception of the exterior steel shell construction, the dryer cylinders are made entirely of aluminum. About 35,000 lb. of aluminum, comprising Alcoa 61 S alloy plate, 63 S pipe for steam tube and finned tube extrusions, and cast aluminum supports were used in each dryer.

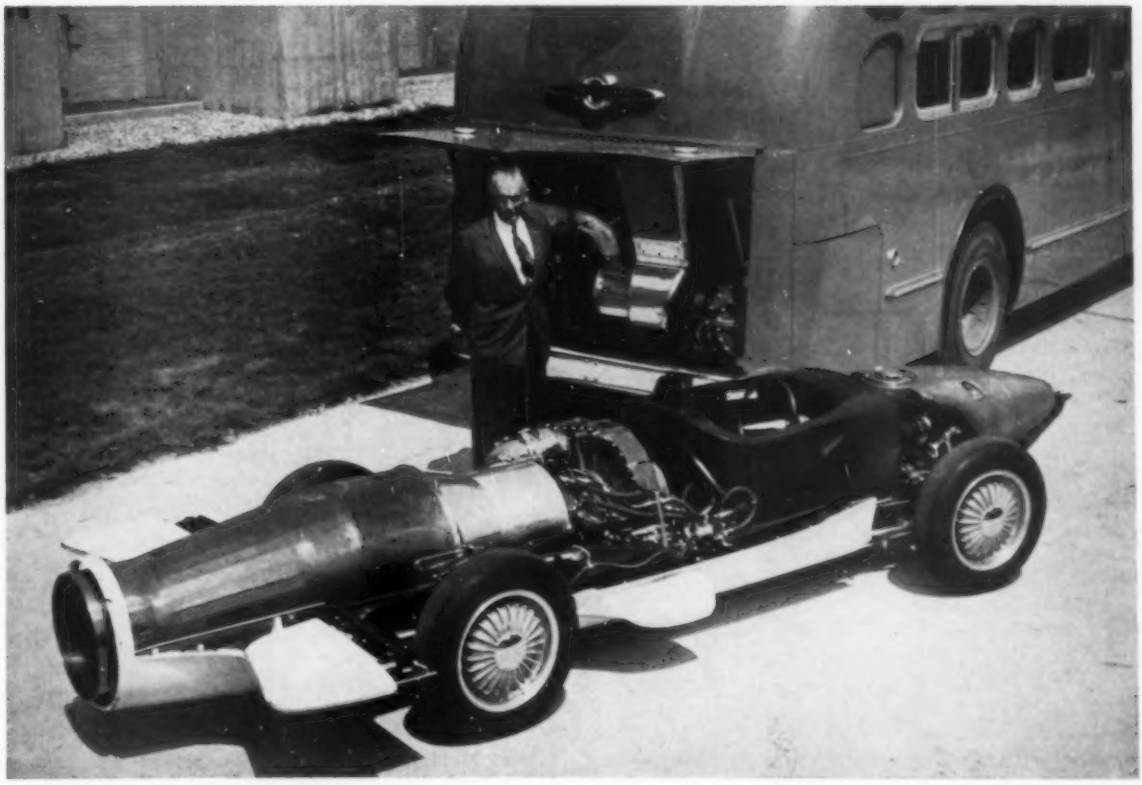
ONE PHASE OF the extensive marine gas turbine research work being done at PAMETRADA—the name coming from the initials of its full title, The Parsons & Marine Engineering Turbine and Development Association, Northumberland, England. Shown below is a bearing shell in which thermistors have been inserted to investigate temperature distribution under working conditions.



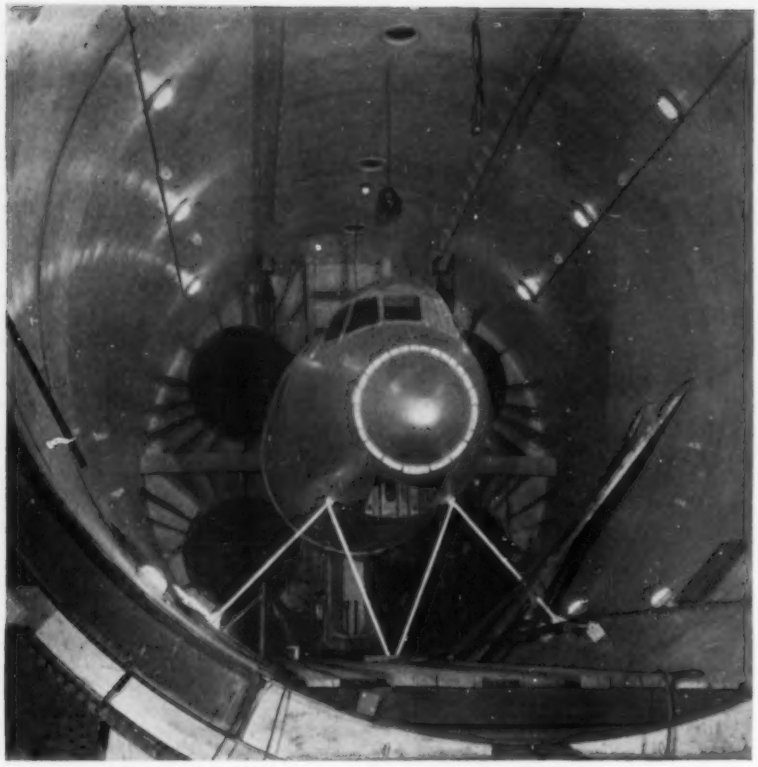


WITH THIS 180 INCH dia. swing metal spinning lathe, Phoenix Products Co. of Milwaukee claims to have the largest horizontal spindle metal spinning lathe in the world. Steel $\frac{1}{4}$ in. thick, and $\frac{1}{2}$ in. thick aluminum can be worked to a depth of 72 inches. The speed of the 50 hp drive, the clutches, brakes, and movement of the tail stock are electrically controlled. The spinning tools are hydraulically actuated.

A 2,000 POUND magnesium rolling ingot, continuously cast in Dow Chemical's Madison, Illinois magnesium plant. Rolled on a 84 in. reversing hot mill, the ingot is shown compared with the 150 lb. rolling ingot used in the country prior to the construction of the new mill.



CHARLES L. McCUEN, head of General Motors Research Labora-tories looks over two experimental gas turbine packages—one the XP-21 Firebird, and the other the new GM Turbocruiser, a GMC transit bus with its conventional diesel replaced by a turbine. In addition to supplying nearly twice as much power as the diesel, the new turbine unit saves over 1500 lb. in engine weight.



THE PRESSURIZED NOSE SECTION, including the flight deck of Vickers' turbo-prop transport installed in the stratosphere test chamber for special testing of the door seal and bolts under varying icing and altitude conditions.

High Altitude Testing at Sea Level

THE AIRCRAFT COMPANY of Vickers-Armstrong, Ltd. in England needed a test chamber to solve some of their ultra-high altitude flight problems, so they designed and built one themselves. The result was a highly versatile unit that is considered to be the largest in the world. Designed primarily as a stratosphere test chamber but which is adaptable as a climatological test unit, the entire unit, including insulation and the test shell, measures inside 86 ft long by 46 ft wide, by 34 ft high. Included in this area are the main test chamber, 50 ft long by 25 ft in dia; the heat lock; pressure lock; and four air circulation ducts each 6¾ ft in diameter.

With this new test chamber, Vickers has minimized the risk of losing expensive experimental aircraft. At the same time, the chamber has paid much of its keep by doing a wide assortment of outside work on a contract basis.

The initial rate of climb in the chamber is 1,500 ft/min at sea level pressure and a temperature of 59 F. This falls off to 1,000 ft/min at 60,000 ft and —76 F. The chambers service ceiling is 80,000 ft (0.395 lb/sq in.), and the minimum design temperature is —85 F. By opening an emergency valve in the 12 in. vacuum duct, the chamber can "dive" from 50,000 ft to sea level in 2 minutes and 40 seconds.

The normal maximum air speed produced in the chamber is 40 knots, though with special nozzles it can be raised to 60 knots.

The cooling plant consists of four 150 hp two-stage ammonia compressors. These cool methyl alcohol, which in turn is circulated at the rate of 20,000 gal/hour through sixteen tiers of copper heat exchange vanes. The test chamber can be reduced from +59 F to —85 F in 30 hours.

Radioactive Tracers Find Many Uses

GENERAL ELECTRIC'S Chemical Materials Dept. has developed what they think is the first peacetime application of atomic energy to the plastics molding industry . . . radioactive tracer techniques to determine the erosion in molds caused by plastic compounds. An immediate result has been an improvement in GE's 12882 thermosetting molding compound over conventional materials.

The new method will detect and measure one part of metal in twenty million parts of plastics, thereby determining the amount of erosion caused in large metal molds by plastics molding compound. As a result, new molding materials that are low in erosion rate are already being formulated, with full-scale production planned for the latter part of 1954.

The Aluminum Company of America is also finding use for radioactive tracers in lubrication evaluation, corrosion resistance studies, analytical chemistry, alloy development, metal flow during the extrusion process, and many other projects.

In the corrosion studies, a piece of metal is immersed in a corroding solution that contains a trace (as little as 0.05 of a part per million) of radioactive material. After a brief exposure, the metal is taken from the solution and a check is made by the Geiger counter. This procedure gives an accurate count of the corrosion material pick-up. Even a photograph of the corrosion areas can be made by placing the metal on a special film emulsion. This film is sensitive to the rays of the radioactive material.

A promising metallurgical application of radioactive tracers is in the study of metal flow during the extrusion of aluminum alloys. Extrusion is limited by slow speeds on hard alloys, and the difficulty of getting a smooth surface on less hard alloys.

By using radioactive tracers, scientists are now able to determine the detailed characteristics of the flow of any small regions of an ingot in the extrusion process. This information will then be used to develop techniques for making higher quality aluminum extrusions more economically.

To study the flow patterns, tiny

pieces of an aluminum alloy, made radioactive in the pile at Oak Ridge, are placed into holes drilled in the ingot. After the ingot is extruded, the flow of metal from the regions "tagged" by the thread of radioactive material can be accurately established by measuring the activity of the extruded sections with a Geiger counter. The exact location of the thread can be established by placing a cross-section of the part on a photographic film so that it will take its own picture.

Survey Reveals Shortage of Metallurgists

THE RESULTS OF A SURVEY of Metallurgical education in our engineering schools, made by The American Society For Metals, indicate a severe shortage, both present and future, of Metallurgical Engineers. The ASM survey indicates that there are now enrolled in engineering schools throughout the country about 2,300 students who are working towards a Bachelor's degree in Metallurgical Engineering. However, those who actually graduate in 1954 may well number less than 10 percent of this total.

Considering the probable defections of those who do graduate, plus changes in careers and all other deviations, the ASM concludes that the total might well be reduced by still another 20 percent. This is far from an answer to the present shortage of Metallurgical Engineers, which is estimated at better than 2,000.

Advanced degrees also entered into the survey—those who are candidates for Masters and Doctors degrees. Forty-seven engineering schools which offer postgraduate studies in metallurgy reported that a total of 747 were continuing their studies. But, even if an expected 90 percent of this group actually pursues metallurgical activities, Industry will still need about 1,500 additional metallurgists.

Metals Industry In For a Change

THE DAY OF the all-around metal may soon give way to the age of specialization, since very few of today's metals have just exactly the correct temperature resistance, light weight, and other properties required for new applications . . . so says a recent issue of the Journal of Commerce.

Outsiders are rushing into the "metals of the future" field, with the chemical companies leading the list, and the steel companies close behind. The list of new metal companies as Uranium producers is almost endless. Almost any company owning land in the western states is in the field.

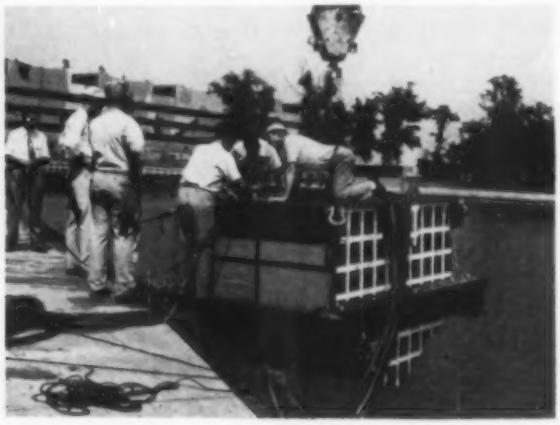
All this is further stimulated by the possible changes in metal forms. Molybdenum, for one, might soon be produced as metallic molybdenum, rather than as an alloy. Other metals, now used as steel additives, may have a future as a pure metal.

Tests Check Design of Seaplane Hull

GLENN L. MARTIN ENGINEERS scramble over a drop test specimen (right) of their experimental M-270 flying boat to inspect it for structural damage following a drop (left). The plane features a high length—beam ratio hull and a forebody bottom cross section with a rounded keel. The new keel introduced relatively unknown local water pressures and structural stresses which needed evaluation.

Sub-miniature pressure transducers were arranged over the specimen bottom to measure pressure distributions during impact, while stresses in the plating, stringers, and floor frames were measured by resistance strain gages. Four vertical, two lateral, and one longitudinal accelerometer were used. Instrument outputs were run through waterproof cables and recorded on oscillographs ashore. The bottom plating over the round keel was held in place with screws, so that it could be replaced by plating of other thicknesses in the course of the tests.

Contact speeds (drop height) of from 20 to 40 feet per second, gross weights of 10,000, 15,000 and 20,000 pounds, and trim angles of 0, 5, and 10 degrees were used. The specimen at left is shown 0.08 seconds after hitting the water at 10 deg trim.



Plastic Coatings For Large Structures

PLASTISOL COATINGS AND LININGS have been used effectively for several years to protect small units against corrosion and abrasion, and reduce depreciation and maintenance costs. Recently, the Arbonite Corp. of Doylestown, Pa. announced that it has the facilities to apply this same protective plastic coating to large machinery and metal structures. Complicated structures 12 ft long by 4 ft at its greatest cross-section have been coated and lined, with larger units possible.

Plastisols are "solutions" of polyvinyl chloride (PVC) capable of protecting surfaces against chemical and electrolytic action, while at the same time offering resiliency, elasticity, and good electrical insulating qualities.

Feedback Control Conference Gets High Praise

VISITORS TO the Second Feedback Control Systems Conference held at the Clardige Hotel in Atlantic City were quite impressed with the manner in which the entire affair was conducted. This conference, dealing with the practical applications of feedback control, gave engineers in various industries a chance to describe in technical sessions, and then demonstrate in scheduled periods, the equipment associated with feedback systems.

The Conference went this way: Papers were presented during the technical sessions held on all three days, with emphasis on applications leading to practical equipment. During the afternoon sessions on the second and third days, actual equipment and components were demonstrated during scheduled demonstration periods held at half-hour intervals. There were fifteen of these demonstrations, and each person attending the Conference was permitted to check off ten that he would like to attend. The attendance at these demonstrations was then scheduled in groups of fifteen to twenty.

The technical papers and demonstrations covered: industrial regulators; tracer or follower machine tools; process controls; nucleonics; aircraft engines; flight path control; fire control; platform stabilization; flight simulators; computers; test equipment; magnetic amplifiers; potentiometers; gears; and dampers. Realizing that there was a need for a common language, the program also included a paper on feedback control terminology.

Variable Area Exhaust Nozzles for Jets

SOON TO BE TESTED is a multi-purpose variable area exhaust nozzle which will incorporate a reverse thrust feature, and at the same time increase the range of turbojet engines. Marquardt Aircraft Co. announced that the nozzle would give up to 35 percent reverse thrust, and positive control of forward thrust independent of engine rpm.

The nozzle can be used to trim area to gain maximum engine thrust on takeoff, and to meet the requirements for water-alcohol injection boost. High speed bombers will be able to alter approach and landing techniques so that drag parachutes will be unnecessary. Approaches can be made with nearly full engine power with all forward thrust spoiled. After landing, the reverser can be actuated to full reverse thrust to stop the plane. In flight, the nozzle can be trimmed to an area which will give the minimum fuel consumption.

Initial application of the nozzle will be on non-afterburning jet engines.

Casting Cleaning Speeded Up

THE CLEANING OF CASTINGS and the correction of defects can be speeded up by using a jet torch, according to the Acco Casting Div. of the American Chain & Cable Co., Inc. A carbon electrode with a small air jet beneath it produces a heat of 6,000 F quickly melts shrinks, cracks, fused-in sand, and other defects. The jet of air blows away the molten metal and slag, and cools the casting. The part is rebuilt with sound weld metal before the casting reaches the chipping and grinding operation. According to reports, the process is relatively inexpensive.

New Blow-Down Wind Tunnel

CONSTRUCTION will be started soon on North American Aviation's wind tunnel, which will be capable of testing plane and missile designs at speeds ranging from 400 mph to more than three times the speed of sound. It will be the nation's largest intermittent, blow-down tunnel, with wind speeds produced by compressed air rushing at selected intervals from a series of large volume storage spheres. Each test will be less than a minute.

For control of the test speeds at sub-sonic, transonic and supersonic levels, an adjustable nozzle, a transonic chamber and a variable diffuser will be placed in series in the throat of the tunnel, rather than separated as in other tunnels.

The test chamber will handle an airplane or missile model with a wing span of about four feet.

Surface Hardening of Titanium

BECAUSE OF ITS SOFTNESS, titanium tends to gall and seize when used in applications involving wear. Horizon, Inc. of Cleveland, Ohio says that by nitriding in an ammonia atmosphere will sufficiently harden the surface of titanium so that it can be used when wear is an important factor. Case depths up to 0.004 in. have been obtained, with hardness values up to 1,700 Knoop. Nitrogen, pack carburizing, gas carburizing, and liquid hardening have also been tried, but without success.

Hydraulics Forum

EXPERIMENTAL when it was arranged, but highly successful in operation was a recent Production Machine Tool Hydraulics Forum sponsored by Vickers, Inc., of Detroit. The reason for its success was the gathering together in one room of the designers of hydraulically equipped machine tools and—the users of those tools. Total attendance was 170, and the viewpoints expressed covered all phases of the hydraulic problems, with the exchange of ideas benefitting all.

FINANCIAL AID TO HIGHER EDUCATION

What Business Can Do to Help Our Colleges and Universities

Is the financial squeeze now gripping our colleges and universities grave enough to warrant direct action by the business community? If so, what can business do about it? This editorial is addressed to these two questions.

In the previous editorial in this series of two, it was demonstrated that **our colleges and universities, and particularly the independent institutions, face financial difficulties, which, unless relieved, promise to get progressively worse and might ultimately result in a national disaster.** This state of affairs obviously gives the business community a crucial stake in helping to relieve the plight of these institutions. For our business organizations can be no stronger than the total community of which they are a part.

It does not follow automatically, however, that every business firm should give direct financial aid to education. Already the business structure is heavily burdened with activities unrelated to its main purpose. These include acting as tax collector for more than $65 billion of federal, state and local taxes in the year 1953. There is a limit to the amount of such public enterprise that can be loaded on the business system.

Business Holds Key to Answer

If, however, the survival of a key part of our educational system depends on its having financial help from the business community, that help should be provided. And this is the situation of our independent privately endowed colleges and universities.

Of course, our tax-supported institutions of higher learning must also be kept strong, financially and otherwise. But they have recourse to public support not available to the independent institutions. Largely on this account, their present financial difficulties are much less acute than those of the independent colleges and universities.

These independent institutions have seen price inflation eat away much of the value of their endowments. Moreover, there is no prospect that these endowments can be sufficiently replenished by gifts from the wealthy people who provided them in earlier years. Progressive income and estate taxes have seen to that. Thus, they are faced not only with a peculiarly acute financial problem, but also one which cannot be solved except by tapping other sources of aid.

Tax Support No Solution

It is conceivable that the independent colleges and universities might solve their financial problem by seeking support from tax revenues. If they did this, however, they would lose their distinctive character as independent institutions, and our system of higher education would lose one of its major elements of strength. That is the existence in our educational system of both independently financed and tax-supported colleges and universities. Each has its special contribution to make to a well-balanced system of higher education.

Business is directly dependent upon higher education to staff its increasingly complex and exacting operations. A key part in this process is played by the small, independent liberal arts colleges which are the hardest hit financially of all our institutions of higher learning. "These," states the Council for Financial Aid to Education, recently formed by a group of business leaders, "have contributed a high proportion of the intellectual, scientific and religious, as well as business leadership of the nation. Their programs are devoted to the teaching of values, particularly the values of freedom. They are a vital bulwark to our system of free enterprise."

Means of Providing Help

There are many means by which business firms can extend help to our colleges and universities. The most obvious, of course, is to make outright grants of money either to individual institutions or to groups of institutions for such uses as the institutions think best. Another means of help, increasingly employed by business firms, is to establish scholarships to pay the full cost of college or university courses of study. Sometimes the scholarships are open for general competition, sometimes they are limited to employees and children of employees of the firm granting them. Not infrequently those winning the scholarships spend some part of their school vacations working in the companies granting the scholarships.

A number of companies have recently provided for what have come to be called "scholarships in reverse." These companies pay a flat sum to a college or university for every one of its graduates they employ. Financing of university research programs also offers a broad avenue for financial aid to our universities by business.

Need Two-Way Communication

Some business firms have well-developed programs for financial aid to education. But they are exceptional. For most companies the problems involved are new and strange. These companies were created with the basic purpose to make money, not to give it away. Successful philanthopic operations involve a whole set of problems with which they have very little experience. Not the least of these is how to make business a dependable source of financial aid to education, since business has no assurance that the profits of one year will not be losses the next.

Considerations such as these emphasize the wisdom of a recent Industry-College Conference on aid to higher education by business, in making the first of its ten conclusions that "better communication, by direct contact, is needed for each [industry and the colleges] to understand the problems of the other." At this juncture the creation of mutual understanding is much more important than the raising of some money and letting it go at that. The problem of aid to education by business has its immediate urgency, but there is also a long-range program to be developed on which business and the colleges and universities must pull together in the years ahead to find a satisfactory solution.

As stated at the outset, failure to find a satisfactory solution could result in a national disaster. This means that, **to give proper heed to their own future prosperity and the future welfare of the nation, business firms generally must go to work on the problem of financial aid to higher education. They must go to work first, to understand the problem; second, to establish two-way communication with our colleges and universities about it; and third, to develop a program which pays proper heed to the needs and capabilities of both business and higher education.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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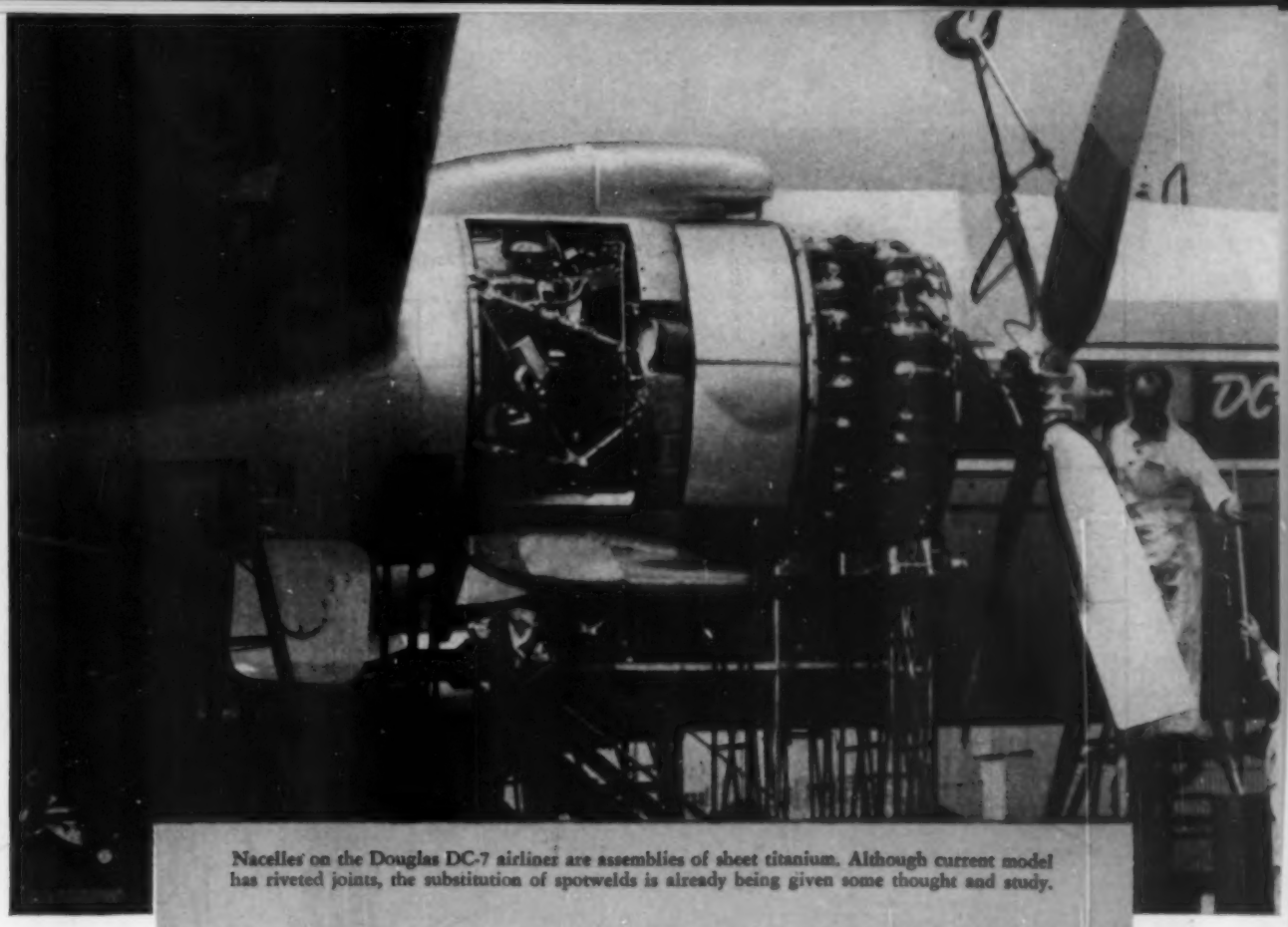


Nacelles on the Douglas DC-7 airliner are assemblies of sheet titanium. Although current model has riveted joints, the substitution of spotwelds is already being given some thought and study.

Strength of Titanium Spotwelded Joints

JOSEPH VIGLIONE*
Aeronautical Materials Laboratory, Naval Air Material Center, Philadelphia, Pa.

STEPPED UP SPEEDS of airplanes have pushed calculated metal skin temperatures close to 600 F where the strength-weight ratio advantage of aluminum is greatly reduced. Designers have, therefore, been faced with the choice of substituting stainless steel and taking a penalty in additional weight, or using some other material having a better weight characteristic.

The Bureau of Aeronautics has initiated a comprehensive program for investigating titanium as a material that will have good strength-weight characteristics at intermediate temperatures, as well as high corrosion and heat resistance. As a part of this program, the Naval Air Experimental Station in Philadelphia was commissioned to evaluate the shear fatigue strength characteristics of RC-70 commercially pure titanium, using clad 24S-T3 aluminum and 18-8 type 302 annealed steel as bases for comparison.

An analysis of the fatigue data led to the following conclusions concerning the relative strengths of the three spot welded materials:

(a) The fatigue strength of tita-

* *The opinions or assertions expressed are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.*

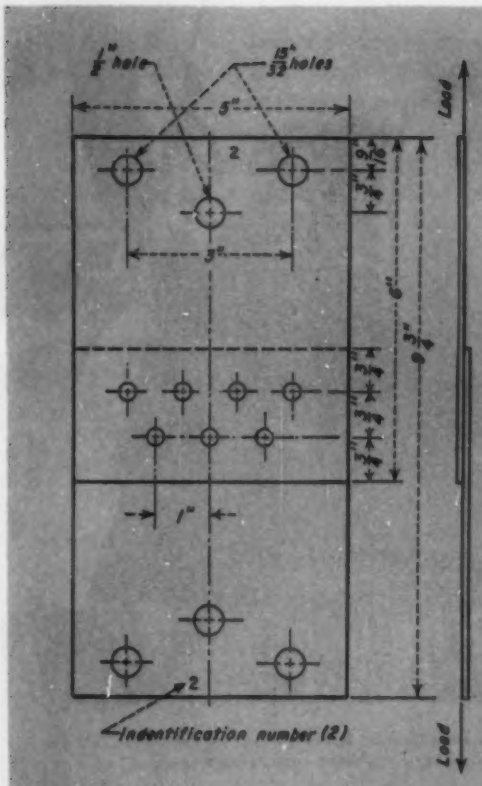


Fig. 1—Specification for spotwelded shear fatigue specimen. Fixture is used to locate seven welds uniformly, mounting holes are drilled or punched exactly in line at time of testing, and all sharp edges removed.

Table I—Average Strengths of Single Spotwelds in Test Specimens

Specimen Material	Thick, in.	Tensile, lb	Shear, lb	T/S Ratio
RC-70 Titanium.....	0.045	775	2,914	0.266
Type 302 Stainless.....	0.047	1,529	1,821	0.839
Clad 24S-T3.....	0.050	252	779	0.323

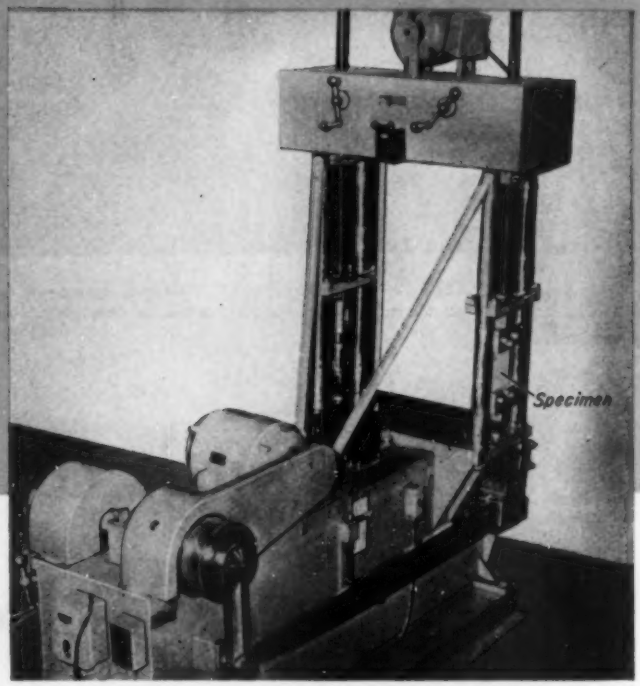


Fig. 2—Krouse direct-stress fatigue machine rated at 15,000 lb utilizes deflection of an elastic load lever to determine force applied to specimen. Flexure plates change angular motion of load lever to linear motion to achieve direct loading on specimen.

nium after 8,000,000 cycles is approximately 7.4 percent less than that of the stainless steel specimens, but 47 percent greater than aluminum. On a strength-weight basis, the fatigue strength of steel and aluminum are only 57 and 98 percent respectively, as great as that of titanium.

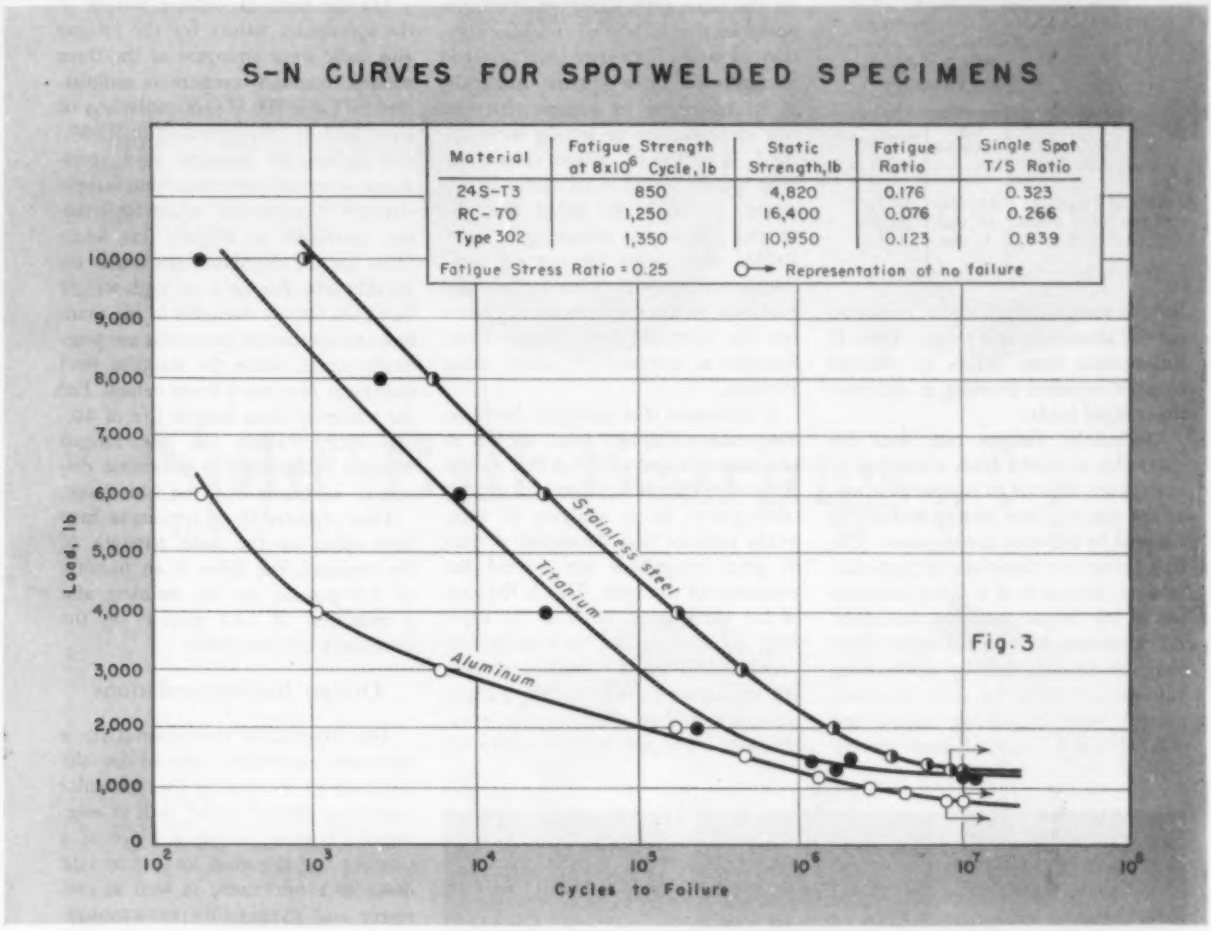
(b) At the comparatively low fatigue life of 10,000 cycles, the fatigue strength relationship between the three spotwelded materials is somewhat different. The strength of titanium is 23 percent less than that of stainless steel, but 90 percent greater than aluminum. On a strength-weight basis, the fatigue strengths of stainless and aluminum are only 69 and 76 percent, respectively, as great as that of titanium.

(c) The fatigue ratios for titanium, stainless and aluminum are 0.076, 0.123 and 0.176, respectively.

Test Details

Specimens as defined in Fig. 1 were spotwelded using a 3.0 in. radius domed electrode on top and a 10 in. radius domed electrode on bottom. Twelve specimens of each material were checked and found to have average single-spotweld strengths as listed in Table I. Radiographic inspection was made of three random specimens taken from each group to ascertain the quality of the spotwelds. Microscopic examination of the spotwelds was also made to corroborate the presence or absence of porosity indicated in the radiographic inspection. This check revealed the size and shape of the spot, as well as the general extent of the heat-affected zone around the fused area.

The three sets of specimens were tested in a 15,000-lb Krouse direct stress fatigue machine, Fig. 2, with holding fixtures arranged so that the tension load is applied axially through the center line of the specimen. The stress frequency used during the tests



was 1,100 cpm and the range of loads applied during each pulsating cycle of tensile load varied between a pre-load value of 25 percent of a pre-determined maximum and the maximum. A stress ratio of 0.25 was thus attained.

The values of the fatigue strengths were determined by plotting S-N curves and noting from them the highest fatigue load withstood by each test group at 8,000,000 cycles. Each test was considered complete when either (1) a fracture occurred, or (2) a slight crack formed which caused a drop in load sufficient to shut off the machine automatically.

Static tensile tests were conducted on a Baldwin Universal Testing Machine, using the same fixtures and arrangement of loading as in the fatigue tests. It was necessary to reinforce the gripping ends of the stainless steel and titanium specimens with $\frac{1}{8}$ in. thick riveted steel plates to prevent rupture of the thin sheet.

After fatigue testing, those specimens which had not failed after 8,000,000 cycles of stress were tested statically to determine to what extent, if any, prior repeated stressing had upon their static strength.

Test Results

The results of the fatigue tests are shown graphically in Fig. 3. Adjacent to these S-N curves are comparative fatigue strength values based on 8,000,000 cycles of stress application and a 0.25 minimum-to-maximum stress ratio.

Typical static failures are shown in Fig. 4. Both the aluminum and stainless steel specimens failed by shearing of the weld metal at the faying or contacting material surfaces. By comparison, the titanium specimens exhibited a button-type failure where part of the parent metal, including all or a portion of the nugget, tears out and remains attached to one member.

Fatigue cracks generally started at the inner junction of the sheets at the edge of a spot and then spread to the outer surface of the identation and laterally from spot to spot until final destruction. This type of failure was to be expected. Photoelastic stress distribution investigations have shown that the stress concentration in a lapped spotwelded joint occurs at the notch between the sheets, and it is at this point that failure started. However, the higher the fatigue loads, the more nearly the fatigue failure approached the static type failures described above. In addition, the S-N curves of the aluminum and stainless steel specimens were uniform with most of the points falling on a smooth curve; whereas test points for the titanium specimens tended to scatter.

As compared to the original static strength values, the static strength of the unfailed fatigue specimens showed little change for titanium, an increase

Table II—Static Strengths of Stressed and Unstressed Specimens

Specimen Material	Static Strength Values, lb	
	Unstressed	Stressed
RC-70 Titanium	16,400	16,150
Type 302 Stainless	10,950	11,575
Clad 24S-T3	4,820	4,300

for the stainless steel, and a reduction for the aluminum specimens. Table II summarizes these values as affected by prior repeated stressing at comparatively light loads.

Ordinarily, fatigue test data for spotwelds obtained from a number of sources are difficult to compare because of the non-uniform testing techniques adopted by different investigators. The data herein are, therefore, of particular interest, inasmuch as a direct comparison of the fatigue strengths was made. All specimens were tested under identical conditions, thereby eliminating various unknown variables generally present when evaluating fatigue test data obtained from different sources. At the same time, however, since the operational objective of this investigation was to evaluate the fatigue strengths of three specific materials, it is reasonable to assume that the best combinations of setting were utilized in order to obtain consisently high quality welds in all cases. In addition, it should be noted that the fatigue phenomena occurring in spotwelded thin sheets are not yet sufficiently understood, whereby an unqualified explanation could be given for the relatively low fatigue shear strength as compared to static shear strength.

It is known that pull-pull loads do not produce simple tension stresses in and around a spotweld, but that a complicated distribution of several stresses takes place. Stress analyses of spotwelds indicate that combined stresses of great magnitude act around the perimeter of the spot. This is the area of the notch stress raiser at the inner face, so that failure is usually initiated at this point. Bending stresses are important factors in low fatigue resistance, and in actual service, compression loads are often introduced.

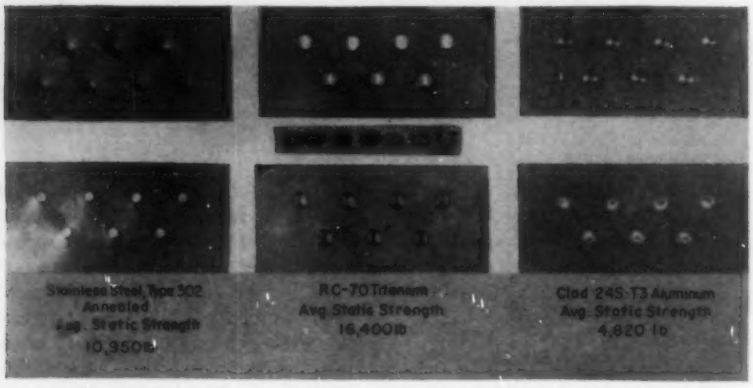


Fig. 4—Typical static failures in spotwelded joints. Aluminum (right) and stainless steel (left) failed in shear at the seven spots. In notable contrast, the titanium specimen (center) separated leaving button-type nuggets attached to one member.

On the basis of relative weight in the specimens, values for the fatigue and static shear strengths of the three welded materials compare as summarized in Table III. Under conditions of light loading corresponding to 8,000,000 cycles, the stainless steel specimens, as tested, have maximum fatigue strength. Comparable values for titanium specimens are slightly less, while those for the aluminum specimens are notably less. But on a strength-weight basis, the fatigue strengths of the titanium and aluminum specimens are practically equal, while the stainless steel specimens give much lower values. For the relatively short fatigue life of 10,000 cycles, Table III, the fatigue strength relationship is somewhat different, especially for the aluminum.

Prior repeated stress appears to have little effect on the static strength of the titanium, but there is an increase of 5.7 percent on the stainless and a reduction of 10.8 percent on the aluminum test specimens.

Design Recommendations

The selection of the material for a spotweld application should be determined by evaluating the particular conditions likely to exist, such as magnitude of stress, anticipated life of a member and the need to keep weight down to a minimum, as well as corrosive and temperature environment. Of the three materials discussed herein, spotwelded Type 302 annealed stainless steel is to be preferred in applications where absolute fatigue strength is of sole importance. When weight conservation is important, either clad 24S-T3 aluminum or RC-70 titanium should be used.

For general all-purpose use where resistance to fatigue failure, weight conservation and resistance to corrosion and heat are design criteria, spotwelded titanium is recommended.

Table III—Relative Shear and Fatigue Strengths of Spotwelded Specimens

Specimen Material	Shear Strength on Weight Basis*		Fatigue Strength**				
			Test (avg), lb	8×10^4 Cycles		10,000 Cycles	
	Static	Fatigue		As Tested	Wt Basis	As Tested	Wt Basis
RC-70 Titanium	2,277	174	1,250	0.925	1.000	0.765	1.000
Type 302 Stainless	803	99	1,350	1.000	0.659	1.000	0.692
Clad 24S-T3	964	170	850	0.630	0.977	0.403	0.760

* Non-dimensional units obtained by dividing absolute loads by density and sheet thickness.
** Maximum values taken as unity.

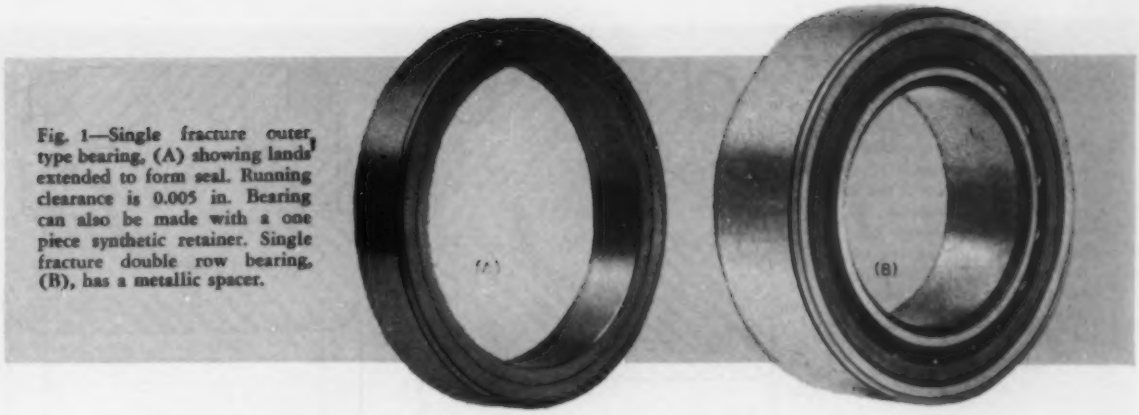


Fig. 1—Single fracture outer type bearing, (A) showing lands extended to form seal. Running clearance is 0.005 in. Bearing can also be made with a one piece synthetic retainer. Single fracture double row bearing, (B), has a metallic spacer.

Split Ball Bearings . . .

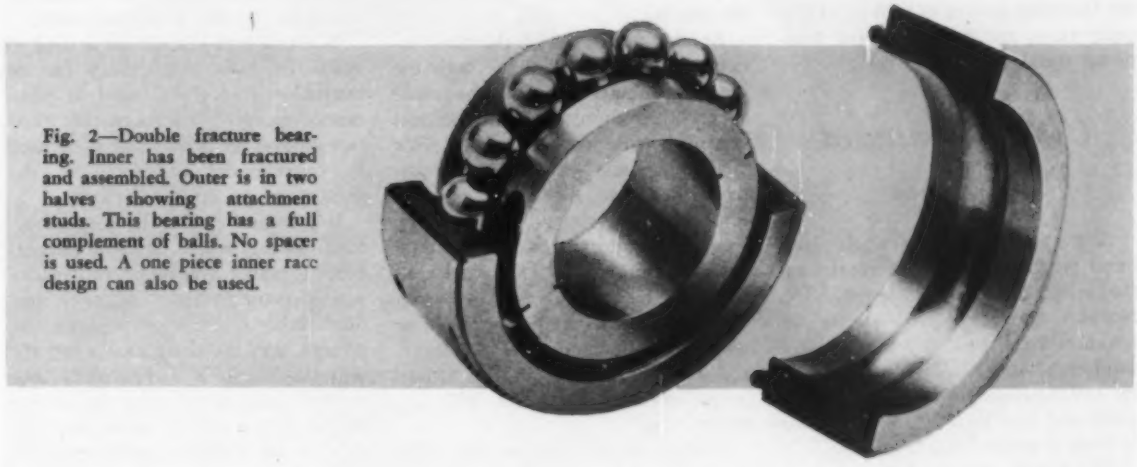


Fig. 2—Double fracture bearing. Inner has been fractured and assembled. Outer is in two halves showing attachment studs. This bearing has a full complement of balls. No spacer is used. A one piece inner race design can also be used.

. . . *And When to Use Them*

FRANK H. STEARNS
Vice President and Chief Engineer
Split Ballbearing Corp., Lebanon, N. H.

THERE ARE TWO TYPES of split ball bearings, each having its use in design. These are: (1) the single fracture outer race (SFO) bearing, Fig. 1, which is used when additional load carrying capacity is needed; and (2) the double fracture bearing, both the inner and outer races of which are split at two points and repositioned by means of taper sleeves and screws, Fig. 2. These are used where a bearing replacement can cause expensive machine down-time or where other types cannot be assembled.

Outwardly, the single fracture bearing, Fig. 1, resembles the conventional types of annular ball bearing. It consists of an inner race of solid construction and an outer race that can be conventional in proportion but is fractured at one point. The division in the outer race permits the spreading of the race to facilitate the introduction of the balls. So that it will not spread under thrust loads, the outer race is either held together at the fracture by a retaining ring or is retained by pressing the bearing into its housing. The ring, Fig. 3, may be either a stamped or welded member and is positioned at the corners of the outer race.

The single fracture bearings described above are distinct from the conventional split ball bearings in which the inner race, the ball separator, the

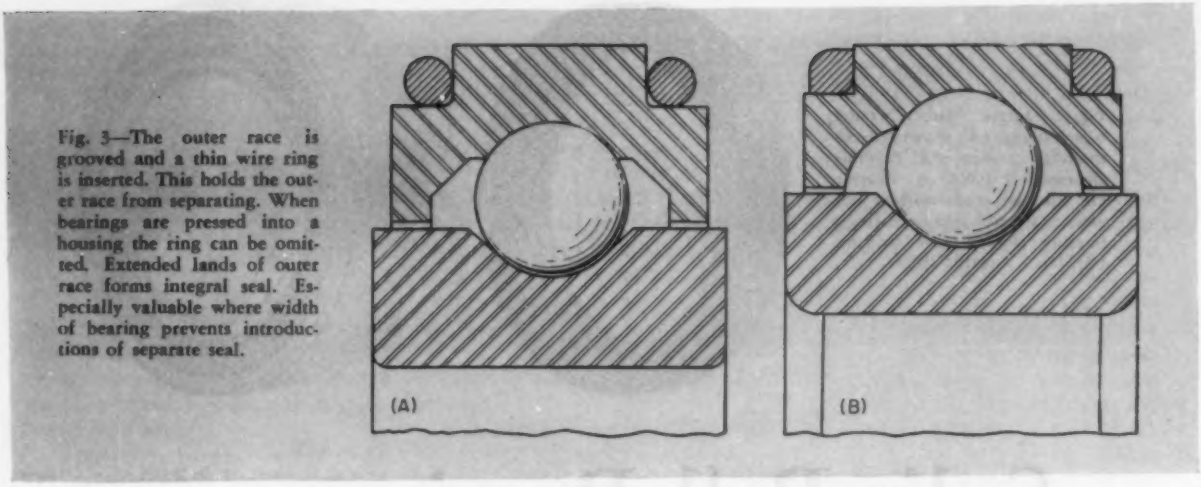


Fig. 3—The outer race is grooved and a thin wire ring is inserted. This holds the outer race from separating. When bearings are pressed into a housing the ring can be omitted. Extended lands of outer race forms integral seal. Especially valuable where width of bearing prevents introductions of separate seal.

shields if used, and the outer race are split, as shown in Fig. 2. These are costly to produce because of the need for fastening devices in both inner and outer races, and because of the additional metal required.

Uses for Fractured Bearings

Any application of a single fractured bearing depends, of course, on the advantages of the design. The bearings once assembled are in all instances treated as any conventional solid race bearings. They can be used in any application involving radial loads and for thrust loads where the bearing is pressed into a housing.

The prime purpose of the construction is to permit the assembly of a maximum number of balls into the races, and so increase the capacity of the bearing (in accordance with accepted formulas).

The load carrying ability of a ball is roughly proportional to the square of its diameter. Therefore, if ball diameter cannot be increased, additional load carrying capacity can only be obtained by increasing the number of balls.

But often an increased capacity is not required; then the same capacity can be delivered in a bearing of smaller boundary dimensions. This is especially important as components continue to be made smaller and smaller. Conventional bearings will meet the load requirements of the installation but not the size and the weight limitation. And conversely, it is possible to design smaller components because of the decreased boundry dimensions of the bearing.

Another advantage of the construction is that the growth in both the inner and outer race can be made deeper than those in a conventional bearing. This increases the rigidity in the rings and where thrust is concerned, adds to the thrust capacity. A part of the outer race land can be brought all the way down to the inner race and can even be interlocked with the inner race. This has two advantages: (1) the forming of a shield or seal that is integral with the races; and (2) an increase in the section height with a consequent stiffening of the ring.

Bearings of this type are now being produced in a variety of sizes wherein the section is not suitable for the introduction of auxiliary shielding devices. Thus, dirt or other foreign matter is kept from entering the bearing, and bearing lubrication is retained.

The construction permits the use of a solid separator instead of the two-piece construction with rivets or clinches as used in conventional bearings. The separator may be stamped or drilled and made of any suitable material, metallic or non-metallic. Limited quantities of split bearings can be produced without spending money on dies to stamp out ball separators or equivalent drilling fixtures for the split cages.

In certain applications, a ball of minus tolerance can be loaded alternately with one of normal size. The minus ball acts as a highly effective spacer or separator of minimum friction. Where starting torque and constant operating torque are considerations, this method is recommended.

When a spring separator is used to space the balls, the springs can be assembled readily and once in place cannot escape. The reason for this: race grooves are deeper than those used in conventional bearings, yet the springs are of larger diameter.

It is logical to use the single fracture bearing when the conventional bearing cannot give sufficient capacity within available space or when one of its other features are required. At present, they are being used when the only consideration is their extra load carrying capacity or where the section height of the bearing is so thin that there is not room to put together the two piece cage required for bearings assembled by eccentric displacement or filling notches.

Other commercial applications involve the use of the bearing in its simplest form—a simple solid inner race, a full complement of balls and a single fracture outer race. These can be in a size range from $\frac{1}{2}$ in. bore to 6 in. O.D. They are limited to comparatively low speeds or where thrust loads are small in relation to radial loads.

One specific case was a pump where space and weight had to be held to a minimum. A conventional 302 bearing with 6 balls was used. Because of the heavy load, there was a bearing failure at around one hundred hours. A single fracture outer 302 with 9 balls was tested. Under the same load, life went to over 600 hours.

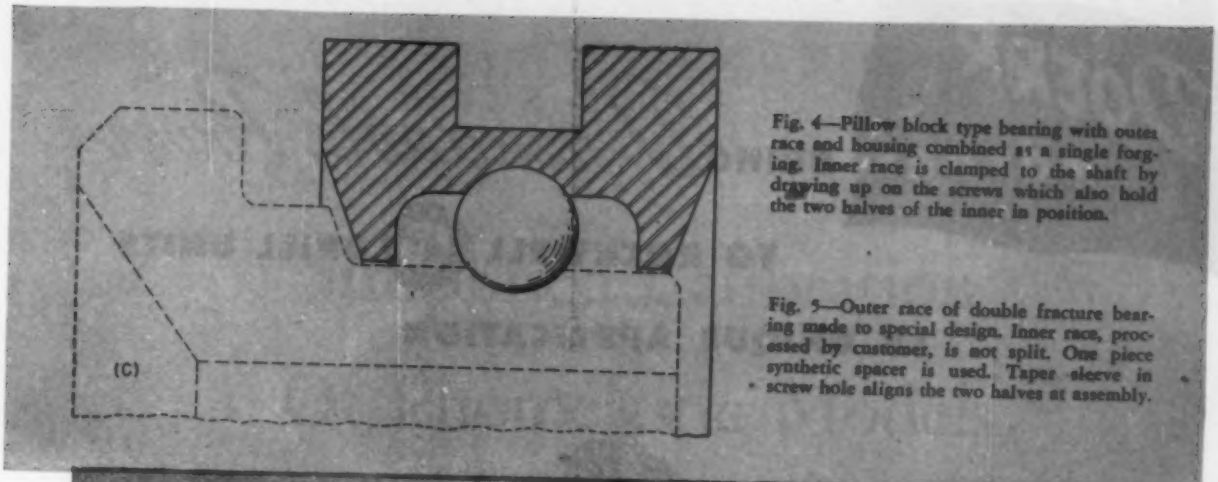
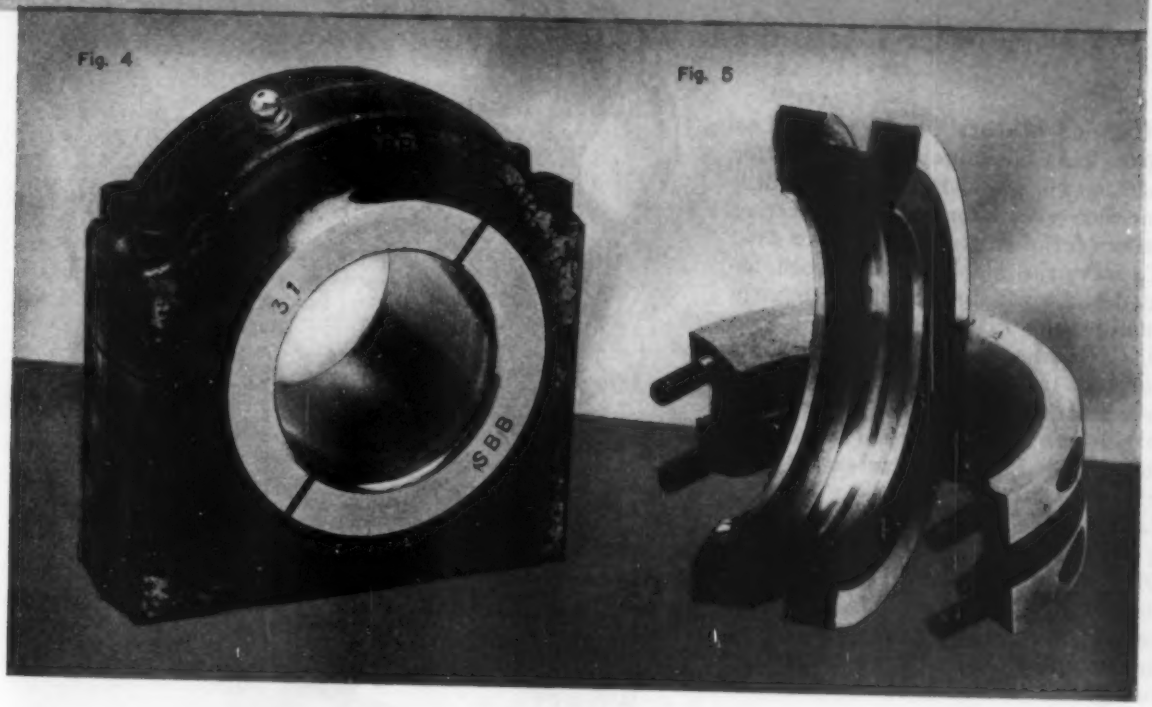


Fig. 4—Pillow block type bearing with outer race and housing combined as a single forging. Inner race is clamped to the shaft by drawing up on the screws which also hold the two halves of the inner in position.

Fig. 5—Outer race of double fracture bearing made to special design. Inner race, processed by customer, is not split. One piece synthetic spacer is used. Taper sleeve in screw hole aligns the two halves at assembly.



Uses for Double Fractured Bearings

The fully split bearing has many of the advantages of the single fractured outer, such as the ability to assemble a full complement of balls and the possibility of including the shields or seals where required as an integral part of the outer race. Also, as downtime for a machine is always expensive, the ability to replace a bearing in minutes instead of hours is highly important. In proper design this replacement can be made without the time and expense of tearing a machine down to replace a failed bearing.

One example of an application of a double fracture bearing was its use in a compressor where lubrication could not be introduced to the pin on the crank throw. A double fracture outer ball bearing was installed and even though it runs dry, has given the required life. (A solid race bearing obviously cannot be installed in such a location.) The use of the double fracture on pins of crank throws has solved many problems in a variety of applications—pumps, compressors, looms, etc.

In several instances, the ability to combine the sealing of the bearing with the outer race has resulted in the development of split ball bearing units that require no housing and serve as pillow blocks, Fig. 4. In these, the outer race can be attached to the related machine part.

The fully split outer race is frequently combined with an intricate inner race, Fig. 5, which is usually fabricated by the machine builder. The bearing manufacturer can then grind the inner race groove and make the assembly. The machine builder, if he prefers, can make the complete assembly, purchasing only the split outer race, the ball, separator and seal from the bearing manufacturer.

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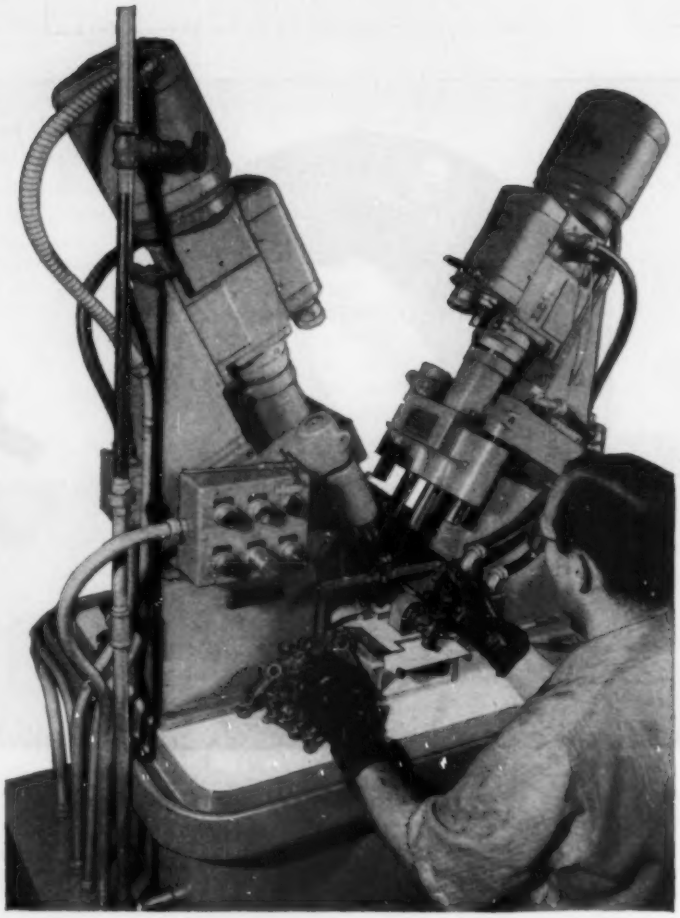

McCulloch Motors Corporation, Los Angeles, had a unique problem—the need for a machine which would automatically drill lubrication holes in forged steel connecting rods for McCulloch's Model 33 chain saw.

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Simplified Calibration Of Photoelastic Models

JAMES H. FLANAGAN
Ordnance Materials Research Office
Watertown Arsenal

PROBABLY THE MOST COMMON METHOD for determining the fringe constant of a photoelastic material is the axial load test. This involves performing a minimum of three calibrations at different stress levels to determine the fringe-stress curve.

However, with the use of the nomograph of Fig. 1, a single load on a disk in diametral compression can be used to calibrate a material. As noted by Frocht (Ref. 1), the disk in diametral compression is a good photoelastic dynamometer; the results are in excellent agreement with theory and the model is simple to produce. Furthermore, it is much easier to obtain a stress free specimen than is possible with tensile types.

If the coordinate system shown on the chart for the calibration model, is adopted, the following equations for the stresses along the X axis can be found:

$$\sigma_x = \frac{2P}{\pi t d}\left(\frac{d^2 - 4x^2}{d^2 + 4x^2}\right)^2$$

$$\sigma_y = -\frac{2P}{\pi t d}\left[\frac{4d^4}{(d^2 + 4x^2)^2} - 1\right] \quad (1)$$

$$\tau_{xy} = O$$

where

P = total load applied, lb
d = dia of disk, in.
t = thickness of disk, in.

The photoelastic material constant can be defined as:

$$f = \tau t / N \quad (2)$$

where

N = fringe order, and
τ = max shear stress

Substituting Eq (1) into Eq (2),

$$f = \frac{4P}{\pi N d}\left[\frac{1 - 4J^2}{(1 + 4J^2)^2}\right] \quad (3)$$

where

$$J = x/d$$

The expression for f in terms of the disk parameters is the one which is solved by the accompanying nomograph.

To use the nomograph, a fringe negative of the loaded disk is required. A load sufficient to establish at least six fringes is desirable, but a minimum of three are necessary. By measuring the distance between successive pairs of fringes where they cross the X-axis of the negative, and dividing that distance by the diameter of the disk as measured on the negative, values of $2 \times J$ can be determined for each fringe order. This technique effectively averages the diametral crossing distances and tends to compensate for asymmetry if it exists.

The data, $2 \times J$, are entered on the right-hand side of the chart and the corresponding fringe orders on the N scale. The function of the curve in the right-hand half of the diagram is to convert the $2 \times J$ data to K where

$$K = \frac{1 - 4J^2}{(1 + 4J^2)^2} \quad (4)$$

With corresponding values of N and K known, a series of points can be plotted that should form a straight line from the lower left-hand corner toward the upper right. By a best fit of the data points establish the slope of the straight line that should now be drawn through the origin $N = 0$, $K = 0$. The point where this line crosses the K-axis should be marked.

The value of w is determined from:

$$w = \frac{P}{\pi d} \quad (5)$$

Connecting the point w and the marked point on the K-axis by a straight line, this line is extrapolated to the f axis. The material constant f is read at the point of intersection.

When working with "frozen-stress" plastics, the scales f_1, w_1 should be used; f_2, w_2 are for the standard plastics at room temperature. If necessary the f_1, f_2 scales can be linearly extended downward and the K scale linearly upward.

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1. Frocht, M. M., "Photoelasticity," Vol. II, John Wiley & Sons, 1948.
2. Timoshenko, S., "Theory of Elasticity," McGraw-Hill Book Co., 1954.

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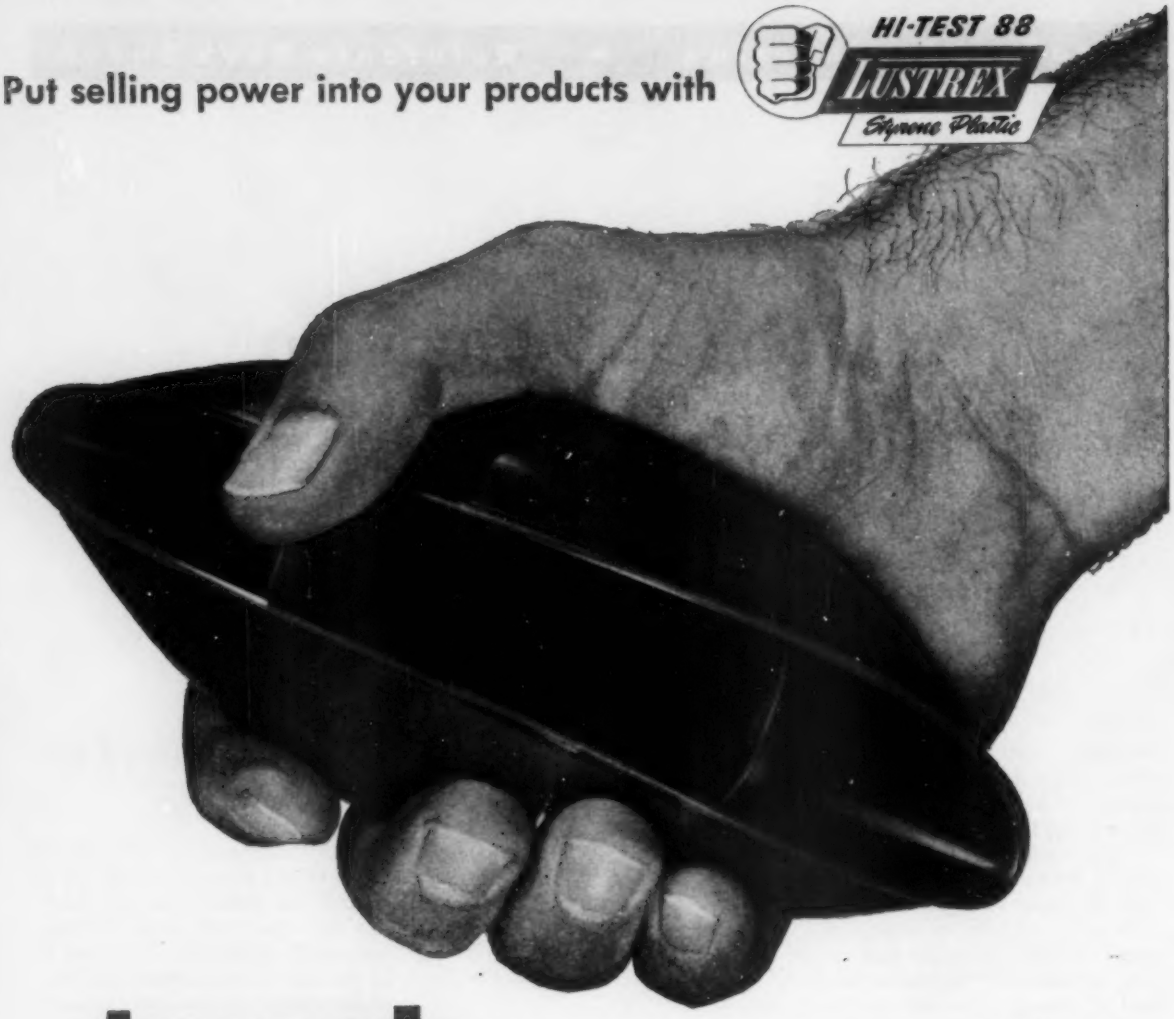

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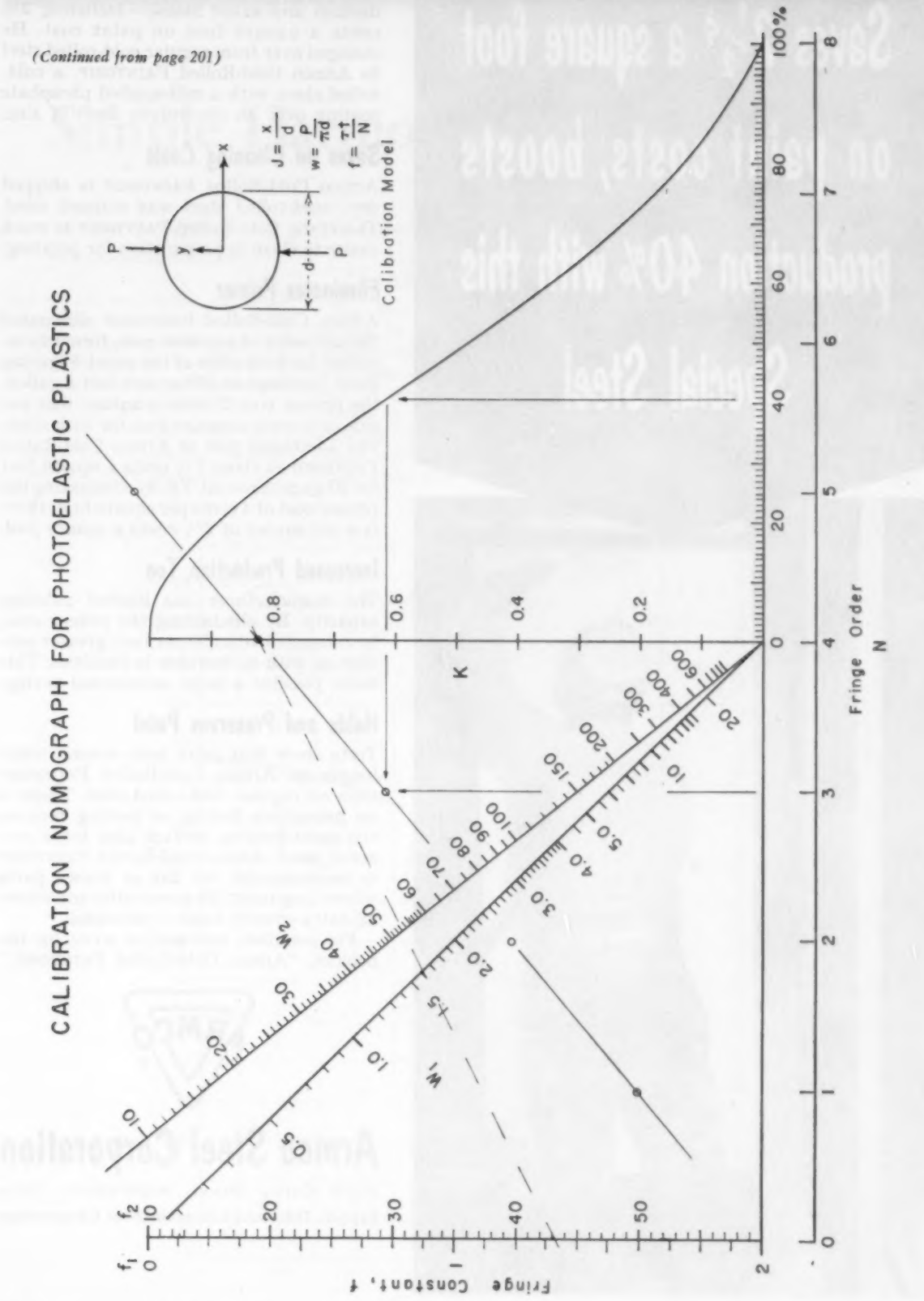

Saves 2½¢ a square foot on paint costs, boosts production 40% with this Special Steel

Here's how one manufacturer boosted production and saved money—including 2½ cents a square foot on paint cost. He changed over from regular cold-rolled steel to Armco Cold-Rolled PAINTGRIP, a cold-rolled sheet with a mill-applied phosphate coating over an electrolytic flash of zinc.

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Simple Harmonic Motion Chart

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Aerojet Engineering Corporation

THIS CHART FACILITATES the determination of the acceleration exerted upon a body moving with simple harmonic motion as shown. Taking the second derivative of the displacement expression, with respect to time:

$$a = -r\omega^2 \cos \omega t \text{ in./sec}^2$$

Letting $\omega = \pi$ radians, the equivalent of one cycle, and replacing $\omega/2\pi$ by f, the frequency in cycles per sec.,

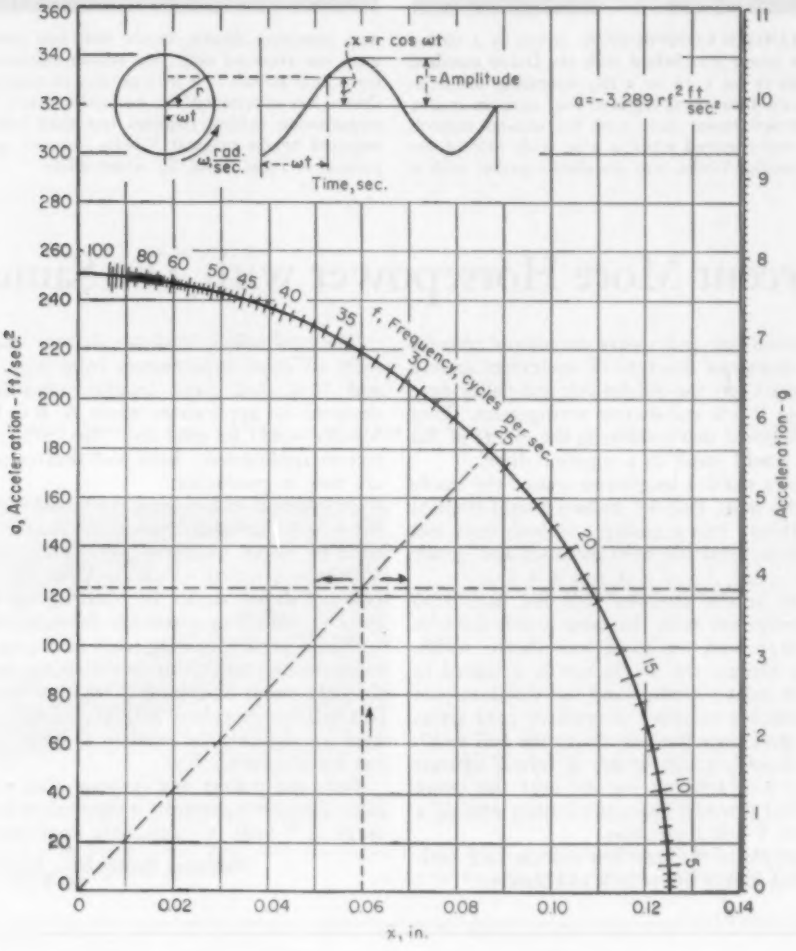
$$a = -\frac{r}{12}(2\pi f)^2 \cos \pi \text{ ft/sec}^2$$

The chart, based on this equation, includes the range of frequency and amplitude values within the range of most practical problems. It can however, be used for larger values by dividing by a factor that brings the frequency and amplitude within the plotted values. The acceleration thus obtained must be modified accordingly.

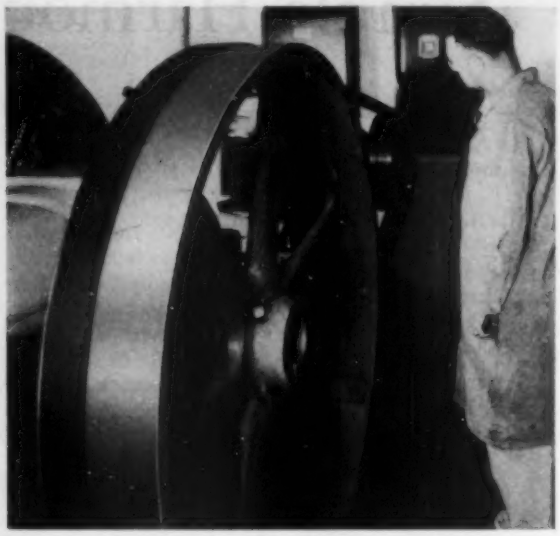
EXAMPLE:

A mechanical device is subjected to a vibration test at a frequency of 25 cycles per sec, and an amplitude of 0.06 in. What is the acceleration? Solution.

The intersection of the vertical line from 0.06 in. on the amplitude scale and the radial line through 25 cycles per sec on the frequency scale establishes a point. A horiztonal line through this point determines the acceleration 123 ft per sec^2, or 3.8 g's.



NEW COMPONENTS-



THIS SINGLE-CYLINDER COMPRESSOR, driven by a 60 hp, 1160 rpm induction motor was belted with six D-210 standard multiple V-belts and is on a 16 hr a day operating schedule. The unit's 14-in. motor sheave was replaced four times in twelve years, despite a pivoted motor base used for tension control. This pivoted base was removed when a 3-in. wide belt of the new type, having parallel V-ribs, was installed together with a new, matching sheave. In the next two years, this new equipment has required only two takeup adjustments to compensate for a total stretch of ½ of 1 percent of original length. The new sheave has experienced no noticeable wear. Note how the new transmission belting requires less than half the sheave width required by the original V-belts. Smooth portion of sheave in picture at right is for fly wheel effect.

Fifty Percent More Horsepower with The Same Width

A new transmission belt and sheave announced recently brings the design history of this type of equipment around full circle. Some years ago, the old flat-belt-and-pulley gave way to the multiple V-belt-and-sheaves arrangement. Ever since, many have believed that combining the merits of flat belts and V-belts would result in a superior drive.

The parallel V-ribs molded lengthwise around the inside circumference of the new "Poly-V" belting would seem to have turned this theory into a reality. As both tests and service records indicate, grip has been increased and sheave wear lessened.

According to the maker, the new belt can handle 50 percent greater horsepower with the same width drive or the same horsepower with one-third less sheave width. Apparently this is because the single belt is designed to mate precisely with sheave grooves and has uninterrupted high-strength reinforcing members of synthetic cord across the entire width. And since the belt covers the full width of the drive (and is not just an assembly of several separate V-belts), the load is distributed equally over the entire driving surface. This provides twice the contact area of a comparable multiple V-belt application.

This design principle of the new belt reduces face pressure one half, giving longer life to belt and sheaves.

The new belt is available in two cross sections, which meet all drive requirements from 3-in. pitch dia sheaves and 50-in. belt pitch lengths upwards. "No. 187" is designed for applications where A, B or C section multiple V-belts would be used and "No. 375" is for C, D or E section applications. Belts and sheaves in a range of sizes are now in production.

In addition to handling more load with less belt width, the new transmission equipment should also make it possible to reduce inventory costs, since matched lengths of V-belts in a variety of sizes will not be needed. Improved belt and sheave service life should help out when replacement is difficult or maximum dependability is desired.

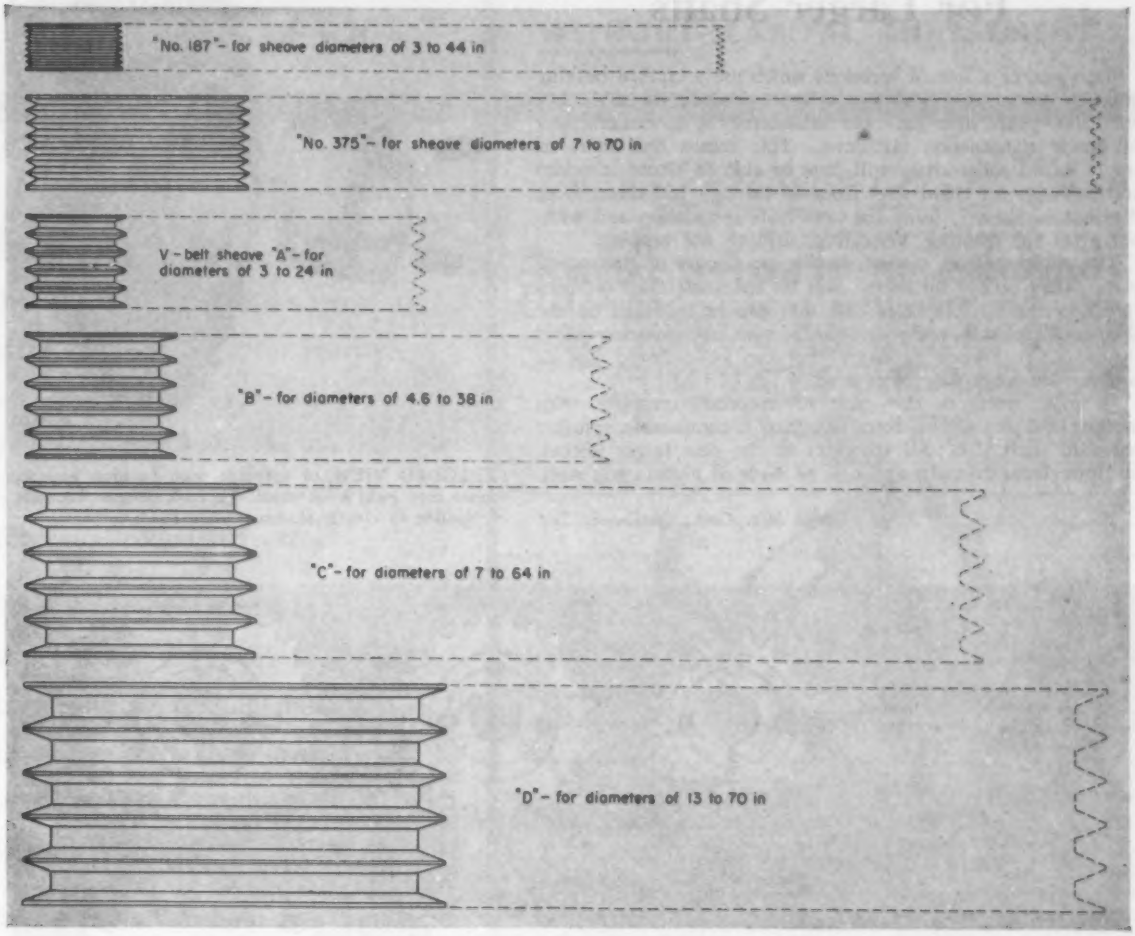
Where present bearing loads are being exceeded because excessive belt tension or where increasing pulley width is the only means of obtaining required horsepower, the new belt will be particularly helpful. And if the belt now being used is a flat one, the problem of keeping it on the pulleys can be eliminated.

Belts and pulleys in a range of sizes are now in production. The new equipment is expected to be in the same price range as V-belts in comparable applications.

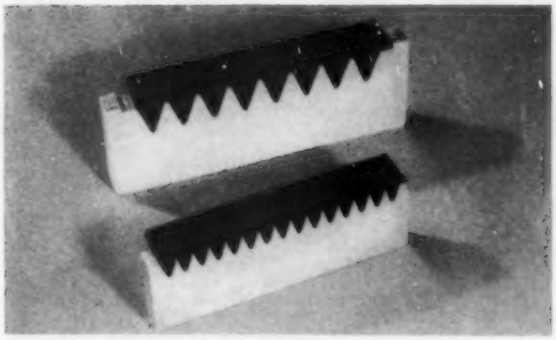
Manhattan Rubber Div., Raybestos-Manhattan, Inc. 61 Willet St., Passaic, N. J.

MATERIALS - PARTS

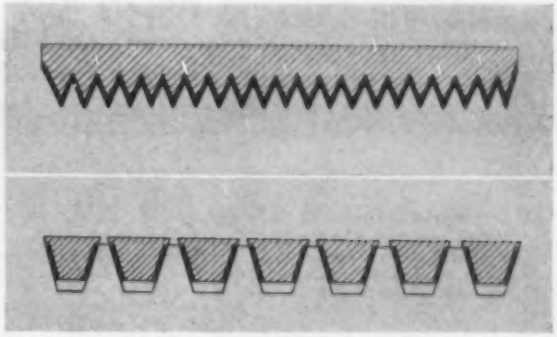
SPECIFIED BY PRODUCT ENGINEERS


"No. 187"– for sheave diameters of 3 to 44 in
"No. 375"– for sheave diameters of 7 to 70 in
V – belt sheave "A"– for diameters of 3 to 24 in
"B"– for diameters of 4.6 to 38 in
"C"– for diameters of 7 to 64 in
"D"– for diameters of 13 to 70 in

COMPARATIVE GRAPH illustrates how new belt reduces the inventory for a 3 to 70-in range of V-belt sheave diameters.



THE NEW transmission belting is ribbed lengthwise and mates with the entire surface of the sheave grooves.



THE NEW power transmission belt is in contact with its sheave over an area twice that of the multiple V-belts.

CONTINUED ON PAGE 208

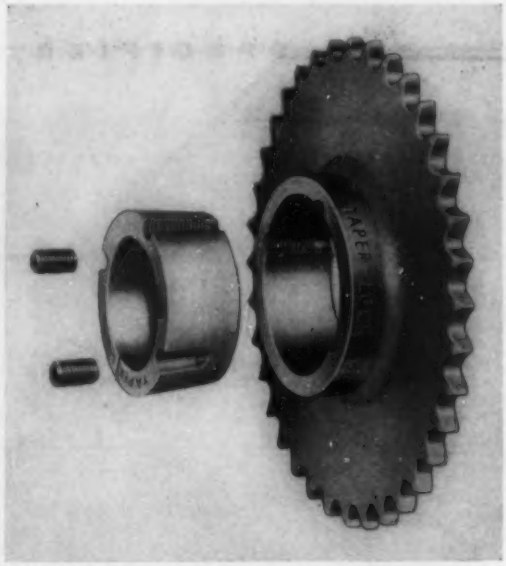
Lock-on Sprockets For Larger Shafts

Extension of a line of sprockets which use a tapered bushing and set screws as a locking device to include the 1½, 1¾ and 2-in. pitch sizes has been announced by a manufacturer of power transmission machinery. This means that users of single strand roller chain will now be able to secure sprockets and bushings for chain sizes from 40 through 160 direct from distributors' shelves, ready for immediate installation and without delay for reboring, keyseating, drilling and tapping.

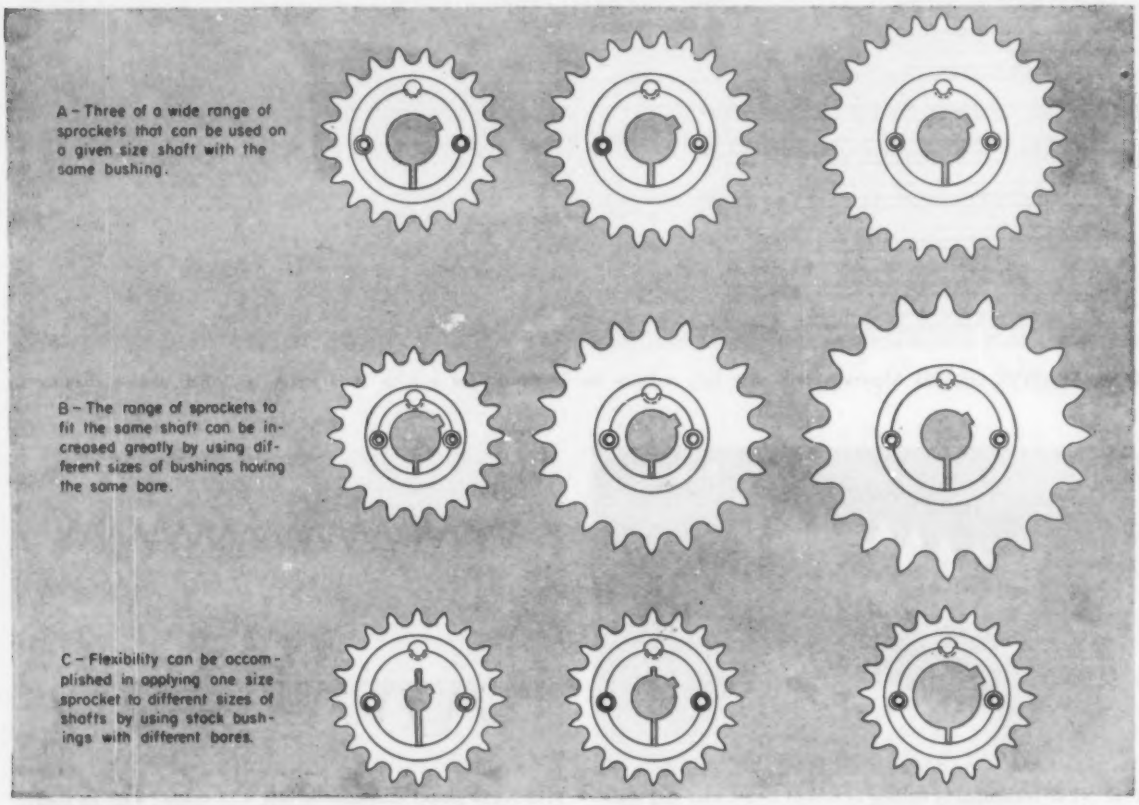
The sprockets are compact, having no flanges or protruding parts. They occupy no more space on the shaft than ordinary sprockets and it is reported that they can be mounted on the shaft quickly and easily and hold with the firmness of a shrunk-on fit. When necessary they can be removed just as simply. Bushings may be re-used.

In most instances this type of sprocket, complete with bushing and set screws, costs less than a comparable sprocket bored to shaft size. All sprockets in the new larger pitches, up through the 26-tooth size, will be made of high carbon steel.

Dodge Mfg. Corp., Mishawaka, Ind.



EXPLODED VIEW of sprocket with bushing and set screws that lock it on shaft. Tapered outside diameter of bushing is clearly shown.


A – Three of a wide range of sprockets that can be used on a given size shaft with the same bushing.
B – The range of sprockets to fit the same shaft can be increased greatly by using different sizes of bushings having the same bore.
C – Flexibility can be accomplished in applying one size sprocket to different sizes of shafts by using stock bushings with different bores.

BY VARYING bore size of bushing and/or sprocket, any shaft from ½ to 4½-in. can be fitted with a wide variety of sprockets.

CONTINUED ON PAGE 210

CMP

COLD ROLLED STRIP STEEL

OFFERS

a practical way

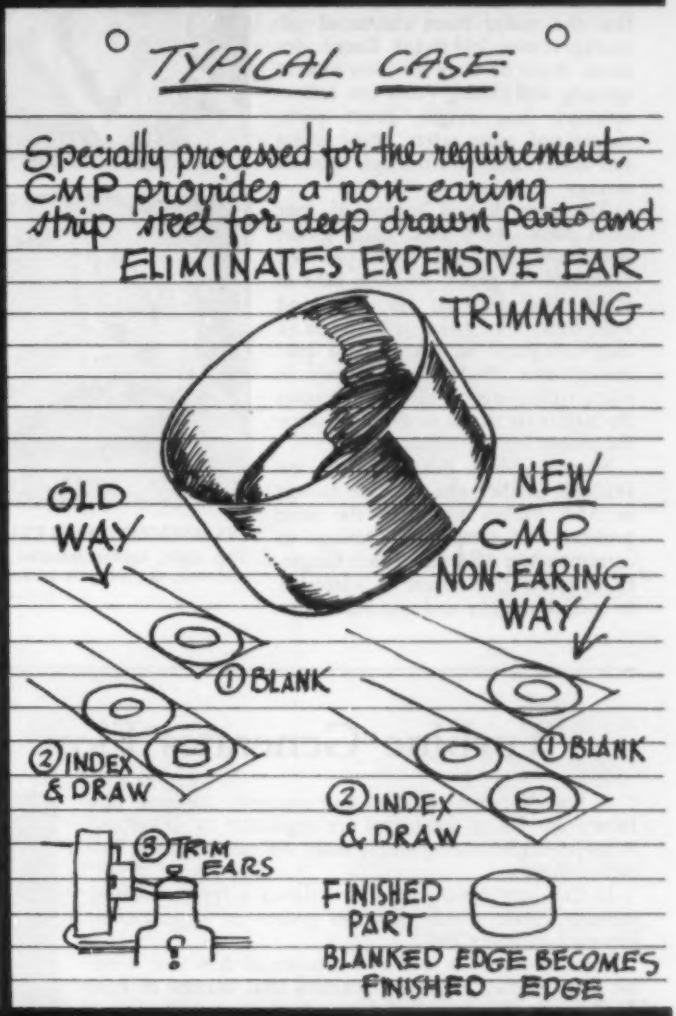
to reduce end-product costs

WITHOUT CAPITAL INVESTMENT

*H*aving ear trouble? If your drawn product requires trimming to remove ears or scallops, you may be able to reduce your end-product cost by the use of CMP non-earing (non-scalloping) cold rolled strip steel.

This is one of many ways in which CMP engineers specifications and processing methods to enable strip steel users to produce better products at lower cost.

Perhaps we can help you to reduce end-product cost without capital investment.


TYPICAL CASE
Specially processed for the requirement, CMP provides a non-earing strip steel for deep drawn parts and ELIMINATES EXPENSIVE EAR TRIMMING
OLD WAY
NEW CMP NON-EARING WAY
1 BLANK
2 INDEX & DRAW
3 TRIM EARS
1 BLANK
2 INDEX & DRAW
FINISHED PART
BLANKED EDGE BECOMES FINISHED EDGE

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6600 McKinley Avenue, Los Angeles — Phone: PLeasant 3-1291

THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC.
4425 W. Kinzie, Chicago — Phone : COlumbus 1-2700

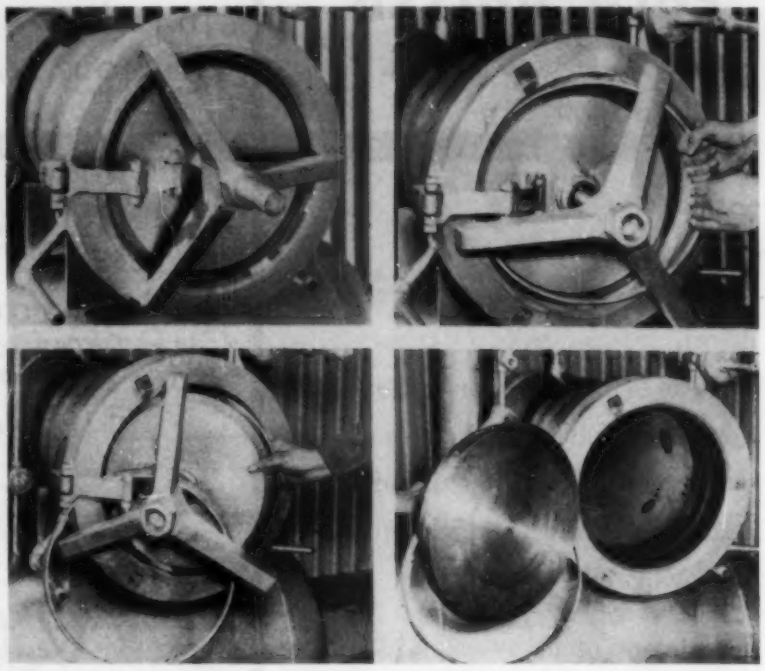
One-Bolt, Flexible Gasket Pipe Closure

A pressure closure for all types of pressure vessels and piping systems employs an internal pressure closing, metal-to-metal seal principle. This will tend to make it seal tighter as the pressure upon it increases.

It is on the nature of this design that the maker bases claims of advantages over old-styled flange closures. Some of these are: less time in opening and closing (only one bolt to operate), less weight, fewer parts, tighter seal, more safety, space saving and lower initial cost through material savings.

The new closures consist of four main parts—weld neck, plug, gasket and spider. A feature is the patented flexible metal gasket which is held in compression between the plug and weld neck. The gasket is flexed to an elliptical shape to allow it to pass through the plug opening. Once in place, tightening the spider nut causes the gasket to return to a round shape for proper seating position.

Standard "Flex Ring" closures are available in the same pressure ratings as ASA flanges and have the same pressure and temperature ratings as corresponding ASA raised face flanges. In addition, the closure is adaptable to special designs and materials.



DISASSEMBLY OF FLEXIBLE RING closure. Top left, unit assembled as in service. Top right, spider released, gasket being removed. Bottom left, after the gasket is removed, the plug is rotated to open. Bottom right, unit completely opened.

Sillers Engineering Co., Box 7193, Dallas, Texas

Turbine Generates Flow Measurement Pulses

A line of turbine-type sensing elements, covering flow rates from 0.3 to 3000 gpm are applicable to rocket and turbo-jet engine testing and to many difficult industrial flow measurements.

In this new device, fluid flow drives a freely spinning turbine wheel, which generates pulses in an externally mounted magnetic coil.

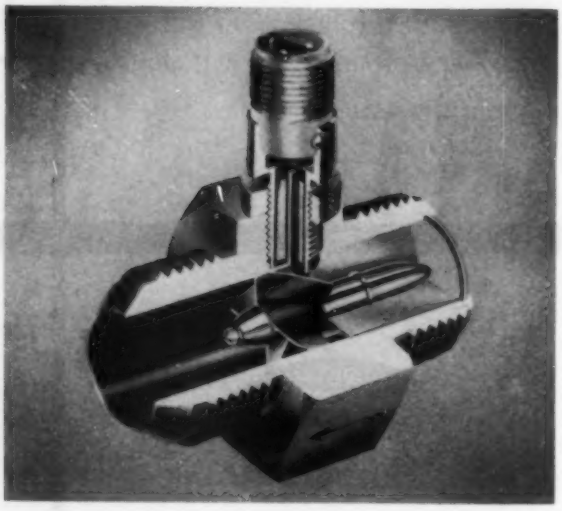
Pulse frequency is used as a mesaure of flow rate, while the total number of pulses measures total volume of fluid flowing past the device's turbine wheel.

To indicate, record, or total fluid flow, either electronic counters or d-c instruments may be used, the later in conjunction with the maker's pulse rate converter.

Simplified rugged design permits accuracies of ½ percent at pressures up to 3500 psi, temperatures from -300 F to 800 F, and under severe shock and vibration. Transient response up to 100 cycles per second is available.

Range between maximum and minimum flow that these sensing elements can handle varies from 6 to 1 for the ⅜ in. pickup to 40 to 1 in the larger sizes.

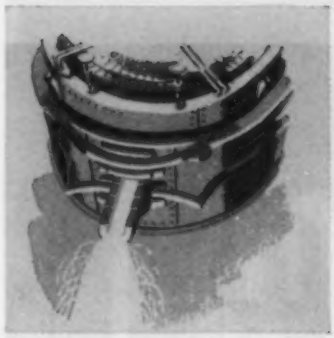
Waugh Engineering Co., 15306 Dickens St., Sherman Oaks, Cal.



CONTINUED ON PAGE 212

7 REASONS WHY
Ostuco Single Source Service Saves You Money!

Wherever you use tubing in any form . . . or wherever the advantages of tubing will make your product more competitive . . . OSTUCO's *single source service* can save you money. One purchase order takes care of all details. Every manufacturing step from raw materials to finished product is carefully controlled and quality-checked. Your production schedules are rigidly maintained. Other advantages of OSTUCO's *single source service* are outlined in an informative booklet, "Ostuco Tubing," yours for the asking. Or better still—for conclusive proof—send us your blueprints for prompt quotation.



1. OUR OWN STEEL SOURCE. *As a member of the Copperweld family, OSTUCO controls its own steel supply . . . your assurance of prompt deliveries.*

2. SEAMLESS AND WELDED TUBING. *As manufacturers of both seamless and electric welded steel tubing, OSTUCO's facilities are flexible to meet your needs.*

3. VARIOUS ANALYSES. *OSTUCO offers carbon and alloy steels which meet all ASM, AMS, ASTM, AISI, and Federal specifications.*

4. FABRICATING AND FORGING. *Under one roof, OSTUCO's modern equipment and skilled craftsmen provide uninterrupted manufacturing, fabricating, and forging service.*

5. SPECIALTY ITEMS. *OSTUCO is especially geared to handle smaller production quantities with the same economy normally possible only in larger runs.*

6. QUALITY CONTROL. *Rigid inspection and precision tests at various stages of manufacture assure homogeneous quality and uniformity.*

7. CONSULTANT SERVICE. *The diversified knowledge and experience of OSTUCO's engineering and design departments is always at your service.*

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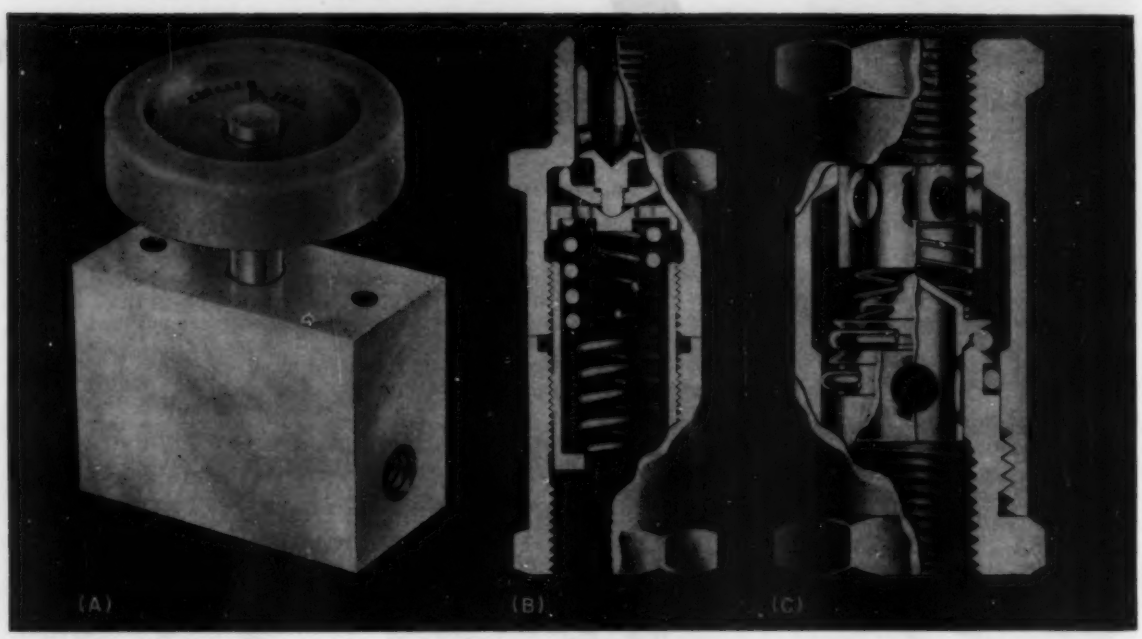
CANADA, RAILWAY & POWER CORP., LTD.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York



(A) This shut-off valve has a positive closure provided by a resilient "O"-ring. (B) Threaded spring retainer in this relief valve permits adjustment within 15 percent of nominal cracking pressure. (C) Larger models of this check valve are now available.

Check, Shut-Off and Relief Valves

A new shut-off (A) and a new relief value (B), as well as two larger check valve models (C) have been announced.

A positive, leak-proof closure is provided by a resilient "O"-ring in the new shut-off valve. Yet the "O"-ring is withdrawn completely and automatically from the fluid stream as soon as the valve begins to open. Throttling is then accomplished by means of a conical metal plug which varies the orifice area. During use for throttling the "O"-ring is not only entirely outside the fluid stream but is completely caged so as to prevent any possibility of "wash-out." The "O"-ring is not required to pass a port or other diametral relief or construction which might damage its surface.

In principle the "900 Series" valve is two valves. The shut-off section employing an "O"-ring is drawn back into the throttling section when the valve is opened, both actions being accomplished in a single motion.

No reversal or abrupt change in direction of flow takes place within the valve, assuring very low pressure drop even when pressure and/or flow rate is high. Rated at 0 to 300 psi, these valves can be used in either hydraulic or pneumatic service and operate smoothly and easily up to their full rated capacity.

In-line design contributes to the ease of mounting and appearance of the relief valve series. Adjustment of cracking pressure within ±15 percent of nominal can be made by using a standard allen wrench to rotate the threaded spring retainer. Interchangeable replacement springs can be used to provide a wider range of adjustment.

The use of an "O"-ring seal, and a spring centering device which allows only axial force to be transmitted to the poppet, results in a valve that combines sensitive operation with unusual durability. The valve exhibits no leakage within as little as 2 percent of the pre-set cracking pressure and re-seats with no leakage within as close as 5 percent of the setting. It is well suited to nearly all gas and liquid services.

Available in either steel or brass for pressures from 50 to 100 psi with male inlet and female outlet pipe threads, sizes are ¼, ⅜, ½ and 1 in. Valve can also be supplied in stainless steel with teflon seal.

The same manufacturer's check valve is now available in 1½ and 2 in. sizes in addition to the smaller models. These valves provide safe operation of systems such as oxygen/propane or oxygen/acetylene, preventing accidental mixing of the two gases in supply hoses. Safety is also stated to be assured in the operation of air-actuated devices in the event of failure or reduction of air or vacuum supply.

This new line of check valves find use in many circuits where two systems are cross connected, preventing escape of high pressure fluids into low pressure lines. Their use is advantageous, for example, in injection lines whereby fluids are pumped into pressurized processing equipment. Their zero leakage prevents the mixture of materials in the lines, and their dependable operation controls or prevents reversal of flow under any circumstances. Valves are available in all sizes in either brass, aluminum or steel.

James-Pond-Clark, 2181 *East Foothill Blvd., Pasadena 8, Calif.*

CONTINUED ON PAGE 214

Have Technical Knowledge at Your Fingertips...

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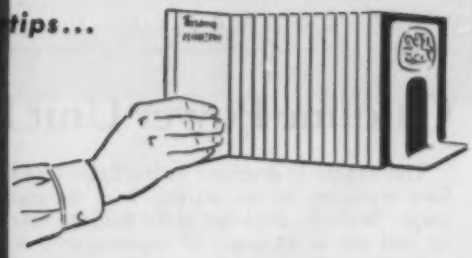

These valuable handbooks belong on the desk of every engineer, designer and production man. Single copies of any or all of them are free when requested on business letterhead. Otherwise each book is one dollar.

A Complete Index of all Reynolds Technical Literature and Films on aluminum design and fabrication is also available. **Write Reynolds Metals Company, 2561 South Third Street, Louisville 1, Ky.**

16 MM Color-Sound Films Available, Too

1. SHAPE OF THINGS TO COME (extrusions)
2. TALE OF THE POWDERED PIG (powders and pastes)
3. PIGS AND PROGRESS (mine to finished product)

Instructors in technical schools are also invited to take advantage of these educational aids. Write for details.

ALUMINUM DATA BOOK—198 tables give complete physical, chemical and mechanical properties; availability data, tolerances, definitions, fabrication information . . . 194 pages.

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REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

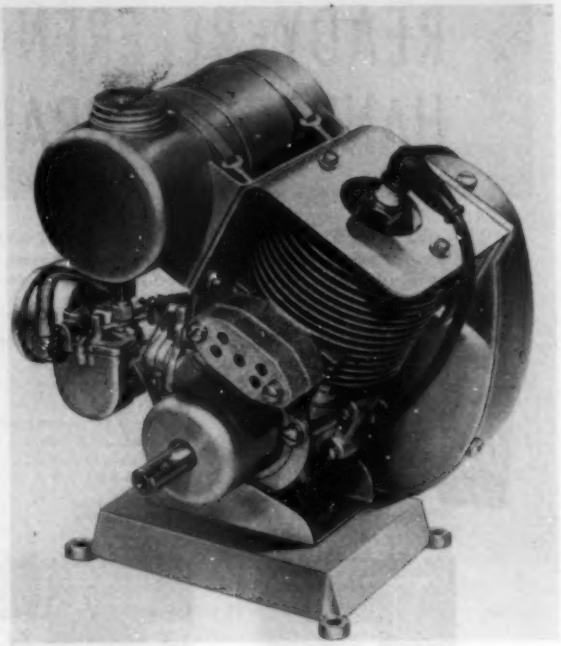
Gasoline Power Unit Has Least Pounds Per Horsepower

This engine is described as the lightest and one of the least expensive on the market. It is designed in a "V" shape. With the crankcase as the hub, the cylinder extends up and out at an angle of approximately 45 deg. The carburetor extends out horizontally on the side opposite the cylinder. The gas tank is in the space between the cylinder and carburetor. The result is an engine that is compact with minimum distance (5½ in.) from the shaft to the outside edge of the engine.

The engine is supplied with a mechanical flyball type governor. However, it is designed so it can also be used with an air vane governor if so desired. This alternative permits its use for applications which require close coupling. In addition, the governor speed on this engine is controllable. Unlike many other industrial engines that use mixing valves, all models have full carburetion.

A shockproof switch is a part of this engine's design. A variety of mufflers is available with this engine.

Standard engines will be furnished with shroud and rewind starter. Due to the smaller cylinders possible with the 2-cycle design, there is a smaller area of compression against which to pull. This means less effort is required to pull it through in starting. At present, this engine will be offered in two models: the "AH-47," rated at 2 hp, weighing 17 lb, the "AH-80," 3½ hp, weighing 26 lb.



Power Products Corp., Grafton, Wis.

Filter Cleans, Dries or Processes As It Moves

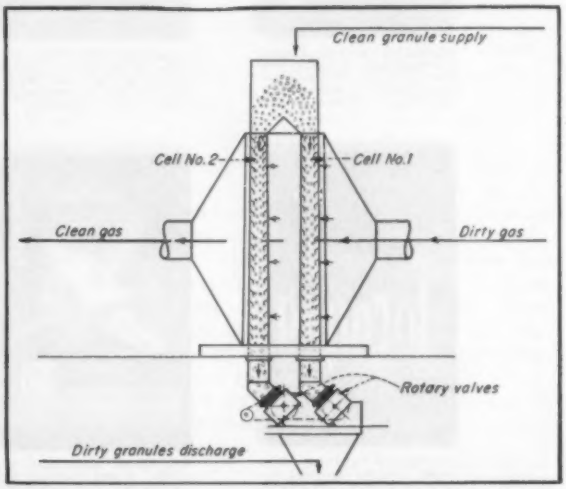
Control of fumes, dust and smoke is accomplished by a unique moving granule principle, rather than by conventional cloth-type bags or water sprays in a newly introduced filter. It is adaptable to air and fume systems of new or existing units. It also can be used for by-product recovery.

In the new filter gases are passed horizontally through two or more cells containing moving granules. Granules of a variety of types of materials are used, depending on the type of filtering being done. The granule cells are arranged in parallel or in series.

As the gases pass through the cells, solid matter impinges on the granules and adheres. The clean gases then pass through labyrinths in the granules to the exhaust system.

The simplest type of filter is a two-cell, parallel-flow system. The descending cross section of each cell increases in area. This inhibits "hang-up" of granules as they move downward and also provides room for the increased volume resulting from the collection of impinged dust. After the dirty granules pass from the cells, they may be washed and then recirculated through the top of the cells mechanically. Each cell is louvered on two faces to allow the gas to pass through.

This new filtering equipment can have any number of cells. Design is flexible so that a series of cells may contain more than one size or kind of granule, each to serve a specific purpose such as moisture absorption, dust removal or chemical composition change.



These filters are recommended for use in controlling fumes or smoke in electric steel furnaces, coke quenching operations, dryers of all types and installations where high temperature, moisture or corrosive conditions are present.

Mechanical Industries, Inc., 929 Grogan Bldg., Pittsburgh 22, Pa.

CONTINUED ON PAGE 216

HERE'S PROOF: You can always count on Continental for every fastener need!

Only Continental Specializes in Special Fasteners

...to meet your every need

Continental has specialized the handling of special fastener orders to better solve your problems. They now turn out well over 5,000 different blueprints each week. Specialized engineers have been assigned to each phase of this fastener production to better concentrate their work and to save you time and money.

Each Continental engineer has had experience producing ground thread taps and gages, with their exacting screw thread dimensions. This training with highest standards of precision is passed on to you in every Continental product. The superior accuracy and greater thread uniformity more than meet your specifications, at no additional cost.

Many times Continental cold forged fasteners have been substituted for expensive screw machine products, improving the product by increasing its strength, while reducing its cost.

Put these standards of precision to work for you on your special orders. It will pay you to call or write us today.

Manufacturers of HOLTITE Fastenings

CONTINENTAL SCREW COMPANY INC. 1904

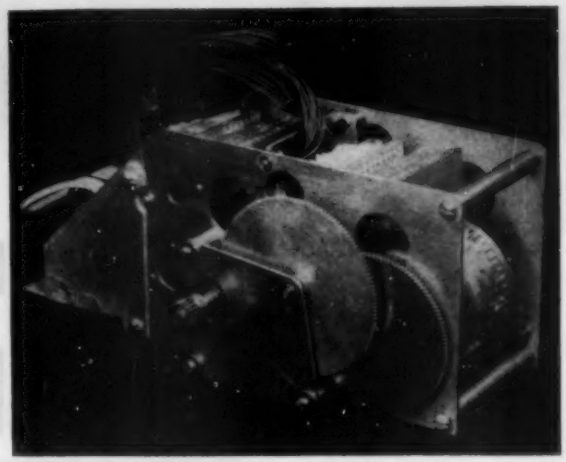
50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.

Digital Converter for Data Handling Equipment

Smaller than a desk telephone, this digital converter converts the analog output of primary sensing devices (flow meters, thermocouples or pressure transducers) into digital signals. Digital signals, represented by contact positions in the new converter are the required input to electric typewriters, digital computers, punch card equipment and other data handling equipment.



Two basic types are offered. One converts a mechanical motion, delivered to its input shaft from a pneumatic or other receiving mechanism, into a digital output signal. Torque requirements are less than 0.20 in.-oz. Low moment of inertia makes the converter adaptable to any servo instrument. The second type of converter which contains an integral self-balancing potentiometer, converts an analog voltage input into the digital signal. The voltage-input type will operate on a 0-1 millivolt input and up, with either a linear or non-linear relationship maintained between input and output signals. Various models within these two basic types make it possible to fill any digital conversion requirement, including dynamic or static readout, linear or non-linear conversion, direct-reading ranges.

In keeping with its ability to handle a wide variety of inputs, the new digital converter can deliver any of an unusually large variety of output signals. It can furnish (1) the decimal code output conventionally used to operate most electric typewriters and IBM equipment; (2) a binary code useful in many computers. In addition, it is the only converter available to furnish teletype, binary-decimal or other special output codes.

Conversion is accomplished by purely mechanical means without relatively complex and costly components such as brush assemblies, electronic circuitry or external equipment. The heart of the unit is a train of from two to ten coded drums, depending on the number of digits required in the output code. Each drum has a series of circumferential hills and valleys and a set of mechanical feelers. The output signal occurs when the feelers, actuated by automatic or manual signal, come in contact with the drum surface. When the feeler encounters a hill, its associated electrical contact is closed; when it drops into a valley, the contact remains open. The combination of closed contacts, for example those representing the digits "16473," thus gives a digital code for one, and only one, value of the variable being measured at that instant. Any number of digits may be supplied in the code by using the required number of code drums. The motion of the input shaft in the first drum is delivered to the successive drums in the series by successive reduction gears.

Positive transfer between successive drums and sets of feelers (the first such transfer successfully accomplished by mechanical means) assures unambiguous, accurate feeler positioning, even though the last drum in the train may move as little as 1 ten-billionth of a revolution. The converter is accurate to the nearest digit, regardless of the number of digits in the output. In a five-drum train, demonstrated accuracy is better than 1 in 34 billion parts. The unit may be obtained with a hysteresis-free input coupler that enables the feelers to operate without interrupting the motion of the input shaft. The device can operate at speeds up to 5,000 counts per second.

Applications for this digital converter are anticipated in oil refineries, chemical plants, power plants and in all test, research and computer installations which must process large masses of data. It can be applied wherever quantities of data must be received, recorded, and possibly evaluated for control or accounting purposes.

Data Reduction and Automation Div., Fischer and Porter Co., 22 Jacksonville Rd., Hatboro, Pa.

DESIGNED TO ALLOW the use of thin wall socket wrenches for high torques and heavy drives, especially where tool clearance is a factor, a new 12-point nut has been announced. By providing 12 points on the nuts to mate with the 12 lands in double hexagon sockets, the driving loads are distributed so that thin-wall socket wrenches of smaller outside diameter can be used without breaking. Fasteners may be more favorably placed and reductions in weight and material are possible through reduced tool clearances. This new unit is made in comparable dimensions in all popular sizes of standard nuts. National Machine Products Co., 44225 Utica Rd., Utica, Mich.

NEW AUTOMATIC BACK PRESSURE CONTROL VALVES automatically maintain a constant back pressure on the inlet side, regardless of variation of pressure at the valve outlet and regardless of changes in demand or flow. Although originally designed for refrigeration use, these new valves have already found applications in other fields where back pressure valves are required, and which call for unusually high capacity. This high capacity is said to be due to the multiple ported seat arrangement. The new units are available in pipe sizes ranging from ½ to 2 in., screwed ends, and with or without a hand wheel for manual pressure adjustment. A. W. Cash Valve Mfg. Corp., Wabash and Morgan, Decatur 60, Ill.

CONTINUED ON PAGE 218

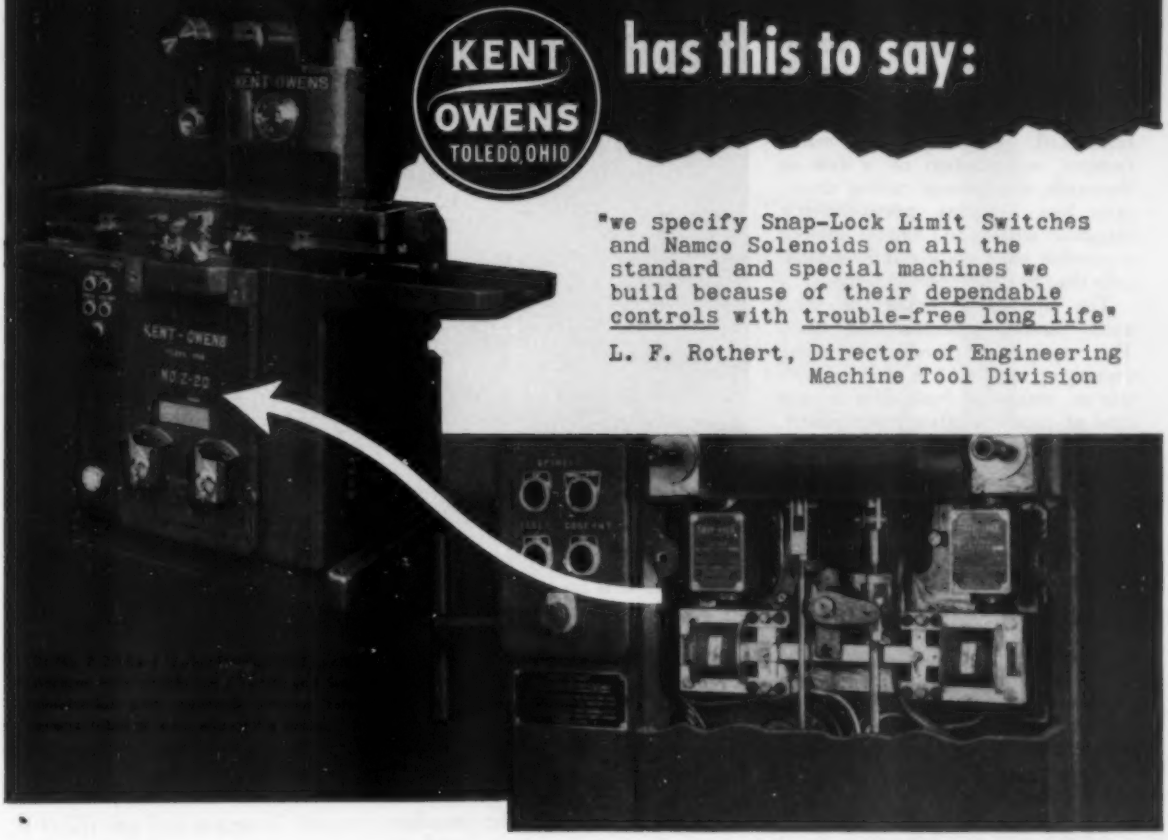
On 15 years experience—

KENT OWENS TOLEDO, OHIO

has this to say:

"we specify Snap-Lock Limit Switches and Namco Solenoids on all the standard and special machines we build because of their dependable controls with trouble-free long life"

L. F. Rothert, Director of Engineering
Machine Tool Division



NOTHING determines the efficiency of your production equipment, and the ultimate cost of its product, so much as the often hidden but vital controls that insure its split second precision, and elimination of down-time losses.

That's exactly the function and the guarantee behind Snap-Lock Switches, designed with separate sealed off mechanical sides, and of Namco "Stellite"-Weld Solenoids. Each is a patented product.

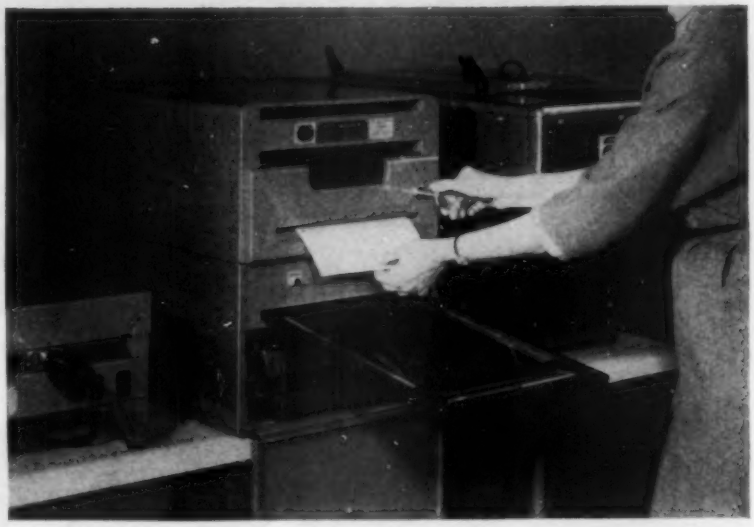
Built first to improve controls—"built with machine tool ruggedness"—for our own Acme-Gridley Automatics, these electrical devices are now specified as standard equipment by 90% of this country's machine tool builders alone. Army, Navy and Aircraft suppliers specify them used singly and in combination. Other uses in valves, clutches, switches and innumerable devices, number in thousands.

If you need to step up a cycle of operation—get rid of mechanical wear, save space and insure more dependable, continuous control of your production, ask our Engineers to help you "design one in" to your machine or process. Engineering specification catalogs—Limit Switches EM-51; Solenoid EM-52.

ACME-GRIDLEY
BAR and CHUCKING AUTOMATICS
1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • Limit, Motor Starter and Control Station Switches • Solenoids • Contract Manufacturing

The NATIONAL ACME COMPANY
170 EAST 131st STREET • CLEVELAND 8, OHIO

Copies Printed Matter For Duplication



Development of new equipment for preparing paper masters of subjects containing halftones and line copy by xerography for run-off of multiple copies on offset duplicators has been announced. According to the manufacturer, reproduction of a few or thousands of copies of catalog sheets, price lists, bulletins, advertisements, magazine articles and similar subjects is possible more quickly and economically than by conventional methods.

The equipment consists of three units, camera, processor and fuser. This equipment permits size-to-size copying up to 8½ x 12 in. material with text or images on both sides on any kind of paper or offset paper master. The processor is used for charging, processing and cleaning exposed plates. The xerographic image exposed in the camera is transferred onto an offset paper master in this unit. After the transfer, the master is placed in the fuser for a few seconds and the image is made permanent for run-off of a few or thousands of copies on an offset duplicator.

A compartment is provided in the processor for convenient storage of blank paper masters, or plain paper for making single copies. A pull-button ejects one for instant use. Plate dispenser at top holds six plates for handy storage and proper rotation.

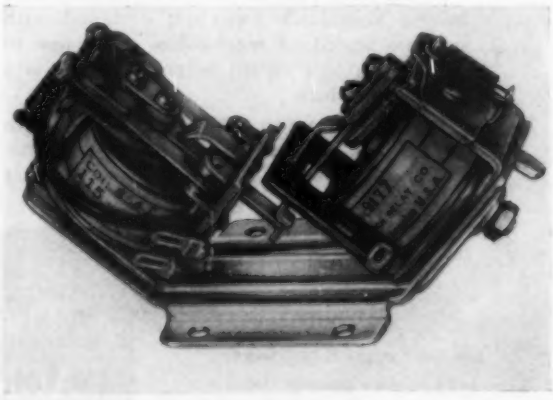
Another camera model is optional equipment. It is used for reduction to 50 percent and enlargement to 150 percent of original size copy on to an 8½ x 12 in. plate. The copyboard holds copy up to 17 x 22 in.

A plate may be used hundreds of times before it requires re-processing. The latent image is removed from the plate in a few seconds in the processor and is ready for re-use.

The process on which the functioning of this equipment is based is xerography, a dry, electrostatic process. A black resinous powder is cascaded over the electrostatic surface of the specially treated plate to make the paper master plate. No water, liquid chemicals or sensitized materials are required. No plumbing or darkroom is necessary. Each unit plugs into a standard a-c outlet.

Haloid Co., 2-20 *Haloid St.*, *Rochester* 3, *N. Y.*

Angle-mounted Latching Relays



These new relays are for electrical and electronic commercial and industrial control applications. They are said to be lightweight and resistant to vibration and shock, incorporating the principle of angle mounting. The relay is designed to give dependable performance mounted in any position—vertical, diagonal.

A new wedge action uses latch faces with a slight radius. End-to-end operation of the latch mechanism assures positive latching regardless of wear or play in armature hinge joints. Standard coils are varnish-impregnated, and surfaces of frame, base and bracket are electroplated.

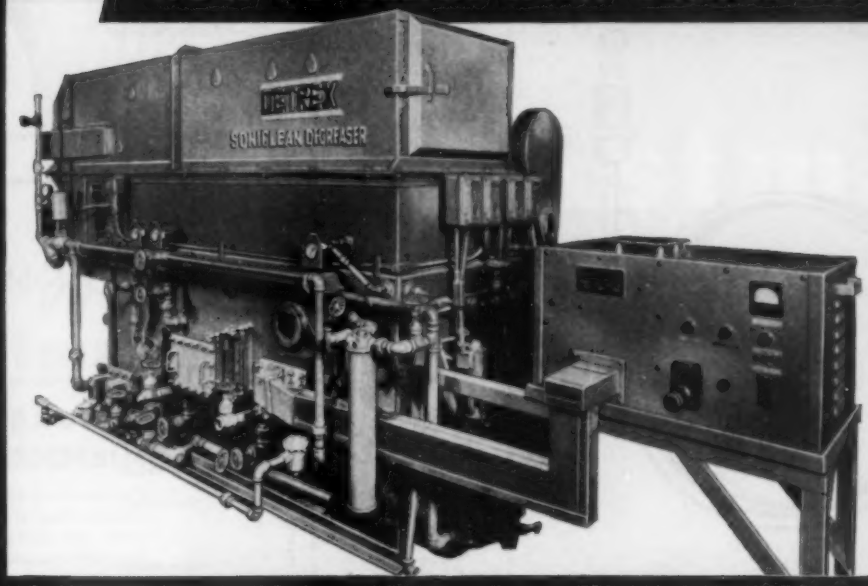
Rating of the new relay's contacts is 8 amp, 115 v a-c non-inductive or 8 amp, 29 v d-c resistive load. The coil is designed for continuous or intermittent duty with resistance to 10,000 ohms.

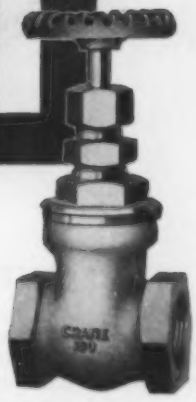
The unit weighs 0.38 lb and is $3\frac{1}{16}$ in. long, $1\frac{7}{8}$ in. high, $1\frac{1}{16}$ in. wide. Both double-pole, double-throw and four-pole, double-throw contact arrangements are available.

Leach Relay Co., 5915 *Avalon Blvd.*, *Los Angeles* 3, *Calif.*

CONTINUED ON PAGE 220

HOW TO CLEAN WITH ULTRASONIC WAVES





another successful product design with piping equipment by CRANE

Solvent—plus sound energy at the rate of 430,000 cycles per second—provides the deep and penetrating cleaning action in this *Soniclean* degreaser by Detrex Corporation of Detroit. Even microscopic soil particles are effectively removed, making it an ideal process for cleaning intricate parts. Source of the sound energy is a special transducer element which overcomes the limitations of quartz crystal previously used for producing ultrasonic waves.

But this new approach to the old problem of cleaning metal still demands the dependability of allied equipment, and for that reason, The Detrex Corporation selects only valves and fittings of known quality. And whether or not your particular design of the moment is concerned with new ways, or an old established method, it always pays to specify Crane. For there's no higher piping quality—no greater valve suitability . . . and no better source of complete specification data.

Crane 150-Pound Brass Valve . . . in the new streamlined design. An ideal specification for all "exposed" applications. A highly dependable, tight-seating valve. Cylindrical upper body is same basic shape as high-pressure steel valves for greater strength and rigidity. Has an improved stuffing box that screws *into* the bonnet—also better stem support to assure true alignment and minimize wear on the packing. Sizes ¼ to 3-inch.

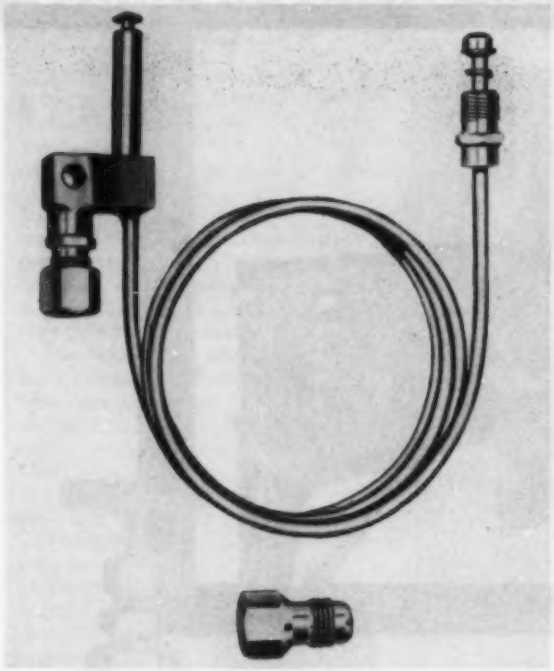
YOU'LL FIND IT HERE ...IN YOUR CRANE CATALOG

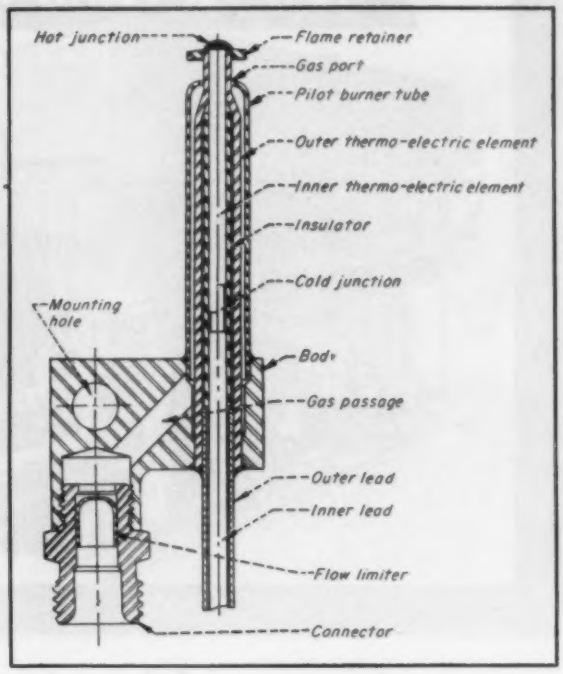
THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING





Automatic Ignition for Gas Appliances

Automatic ignition equipment for gas ovens, laundry dryers, water heaters and wall heaters consists of a combination pilot burner and thermocouple in one compact unit. Gas input is said to be especially low, which assures cool standby operation that will not affect room temperature.

The new pilot also solves a service problem that is confronting gas appliance dealers. Because it is non-aerated, the tiny pilot cannot become clogged with lint, a major cause of service calls on this type of equipment.

An encircling blue flame on the pilot head provides a constant source of heat to the built-in thermocouple, which is available in all standard lengths. Used in conjunction with automatic shut-off devices, the new pilot provides safety protection in its operation.

The new igniter will handle all gases without any change in the orifice and can be considered as universal.

Robertshaw Thermostat Div., Youngwood, Pa.

UNIFORM PERFORMANCE even when exposed to severe temperature changes, corrosive atmosphere and high humidity is said to characterize a new voltage divider. The unit is available with any number of voltage divisions up to 23, any spacing, and a maximum total resistance of 30,000 ohms. Resistance tolerance on each section can be held to ± 0.5 percent of the section resistance. The use of potting compounds in the unit make it impervious to fungus, vibration, acceleration or shock. The unit is 4$\frac{1}{32}$-in. long with a diameter of 1$\frac{3}{4}$ in. and a mounting flange 1$\frac{3}{16}$ in. square. G. M. Giannini & Company, Inc., 39 Main Street, East Orange, New Jersey.

PHOTOCOPIES can now be made on both sides of a single sheet of paper to be used with the photocopy machine made by the same company producing the paper. This new product was developed to meet the need for two-sided copies of originals printed on both sides. The new paper is made to handle letterhead, legal and book page-size copy, as well as larger material up to 11 in. wide, any length. There is no limitation as to the type of paper, documents or originals that can be copied, regardless of whether the original is on opaque or transparent paper. American Photocopy Equipment Company, 1920 West Peterson, Chicago, Illinois.

HERMETICALLY-SEALED TIME DELAY RELAYS of a new design are now being put into production by a manufacturer of stop clocks, a-c and d-c timers, chronometrically governed d-c motors and timing motors. Designed to take up less space than previously required, these time delay relays can be supplied with 50, 60 or 400 cycle a-c or governed or standard d-c motors. The unit is enclosed in a lightweight aluminum hermetic housing, 2$\frac{1}{2}$ in. in diameter. The basic length for a single switch unit is 2$\frac{5}{8}$ in. Weight of the unit is about one pound. A 3-stud or flange-type mounting is available. The A. W. Haydon Company, 232 N. Elm Street, Waterbury, Connecticut.

CONTINUED ON PAGE 222

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

specify

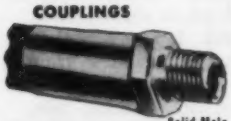
Eastman

first in the field

HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS

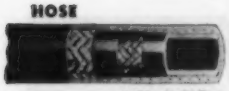


Solid Male

Swivel Male

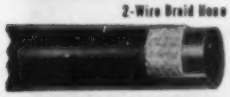
Swivel Female

HOSE



1-Wire Braid Hose

2-Wire Braid Hose



1-Fabric Braid Hose

2-Fabric Braid Hose

Spiral Wire Hose

Write

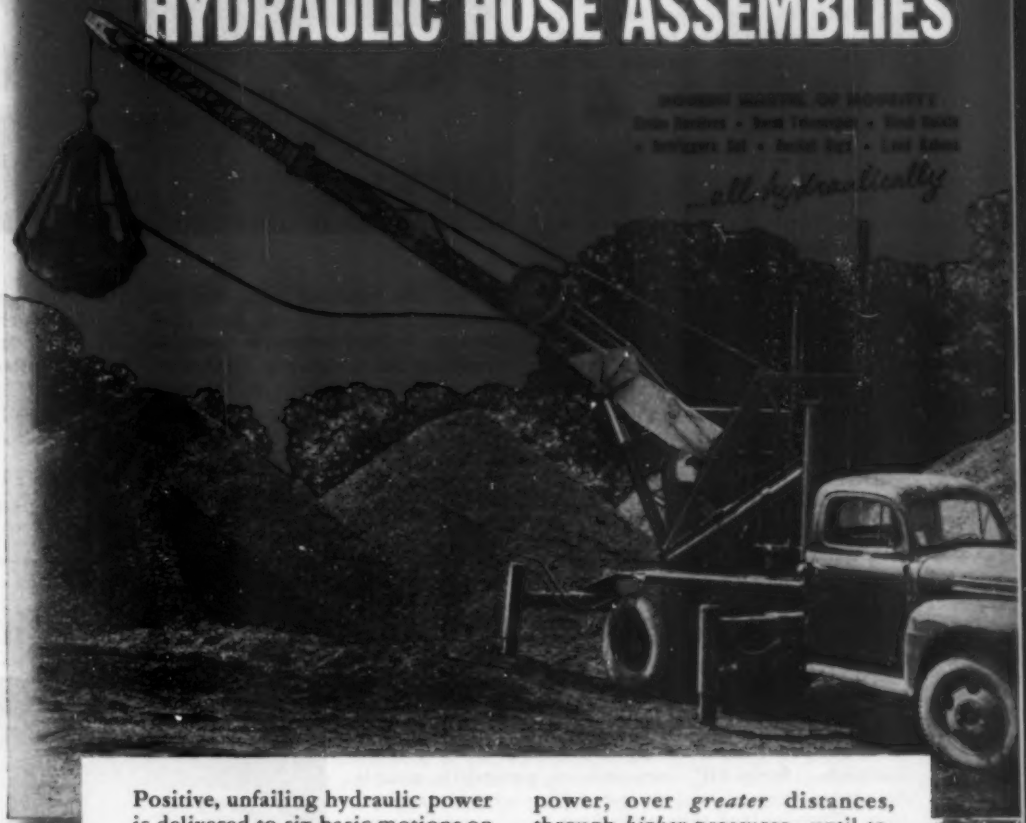
for free catalog 100 on Eastman hose couplings and fittings.

6 HYDRAULIC MOVEMENTS OF BUCYRUS-ERIE HYDROCRANE RECEIVE POSITIVE POWER THROUGH...

Eastman

first in the field

HYDRAULIC HOSE ASSEMBLIES



Positive, unfailing hydraulic power is delivered to six basic motions on many Bucyrus-Erie H-3 Hydrocranes through dependable Eastman Hydraulic Hose Assemblies.

Eastman, *first in the field* of Hydraulic Hose Assemblies, pioneered in many original applications of mobile hydraulic power. As early as 1926, J. Peter Eastman experimented with wire braided hose.

Continued Eastman developments have made it possible to apply *more* power, over *greater* distances, through *higher* pressures—until today, 6,500 psi are withstood by the Eastman 3-wire braid hose assemblies used on many Bucyrus-Erie H-3 Hydrocranes.

Take advantage of our 25 years of experience in the application of mobile hydraulic power to manufacturer's original equipment. Engineering consultation on special problems is our specialty . . . complete service yours to command.

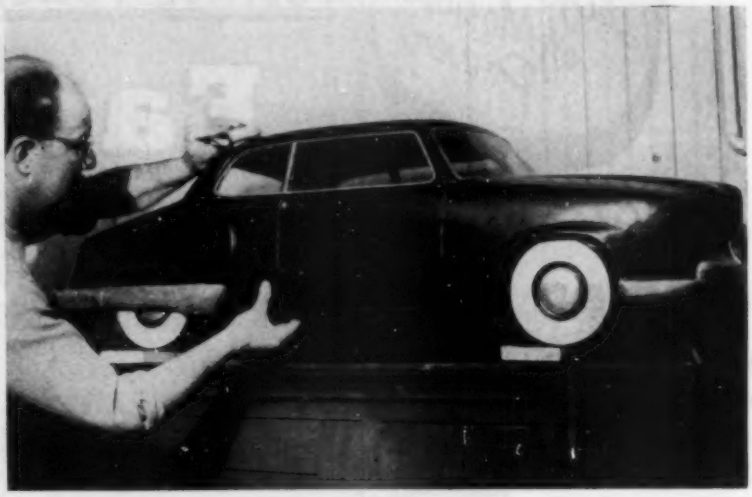
Eastman

MANUFACTURING COMPANY

Since 1914

DEPT. PE7, MANITOWOC, WISCONSIN

Models Like Clay Then Hardens into Metal



Designers, model-makers and patternmakers may now work with a modeling metal formulated of virgin aluminum, resins and aliphatic solvents. In its original state it is like a clay or putty. It air-hardens into a compact, high-strength mass with reported good stability, corrosion resistance, wear and permanency. It may be used anywhere in shop or plant since no heat, chemicals, flame or flux is needed to set it.

Models and prototypes, molds for vacuum forming, dies for embossing leathers and similar materials can be made with the new material. Expensive hot metal casting and all intermediate steps are eliminated.

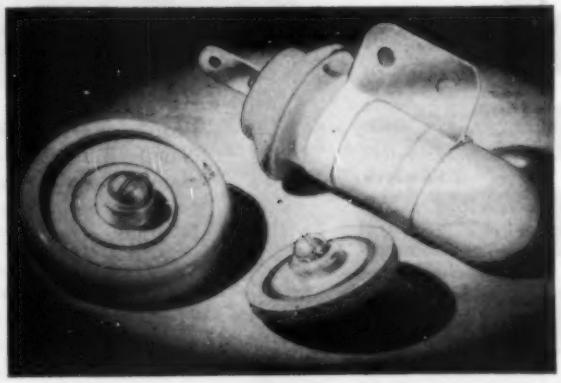
Using "Sculp-Metal" is simple. Of clay-like consistency, it is spread with a spatula, squeegee, putty-knife or the fingers. The material is applied in successive layers, of about $\frac{1}{8}$-in. thickness, until required contours and shapes are achieved. Sections may be built in one work session or over several since multiple layers fuse together into an integrated mass. Thinned with a special solvent, the new "clay" can be sprayed or brushed over wood, plaster and other materials to form a watertight aluminum skin.

Drying begins immediately and varies with the thickness of the layers applied. The hardened metal may be carved, drilled, tapped, machined and otherwise worked. Extreme surface smoothness and a variety of finishes—from brushed aluminum to mirror-bright—are obtained by filing, sanding and burnishing. If required, the material can be painted with lacquers, synthetic enamels and oil-base paints. No primer is needed before painting.

When completely cured, Sculp-Metal is reported not to shrink, crack, chip, check or peel. It is harder than lead; withstands temperatures from minus 65 to 350 F.; it is weatherproof and rustproof; resists gasoline, oils, greases, alkalis and most acids.

The Sculp-Metal Co.,
701-10 *Investment Bldg., Pittsburgh 22, Pa.*

Disk and Tubular Capacitors That Do Without Mica



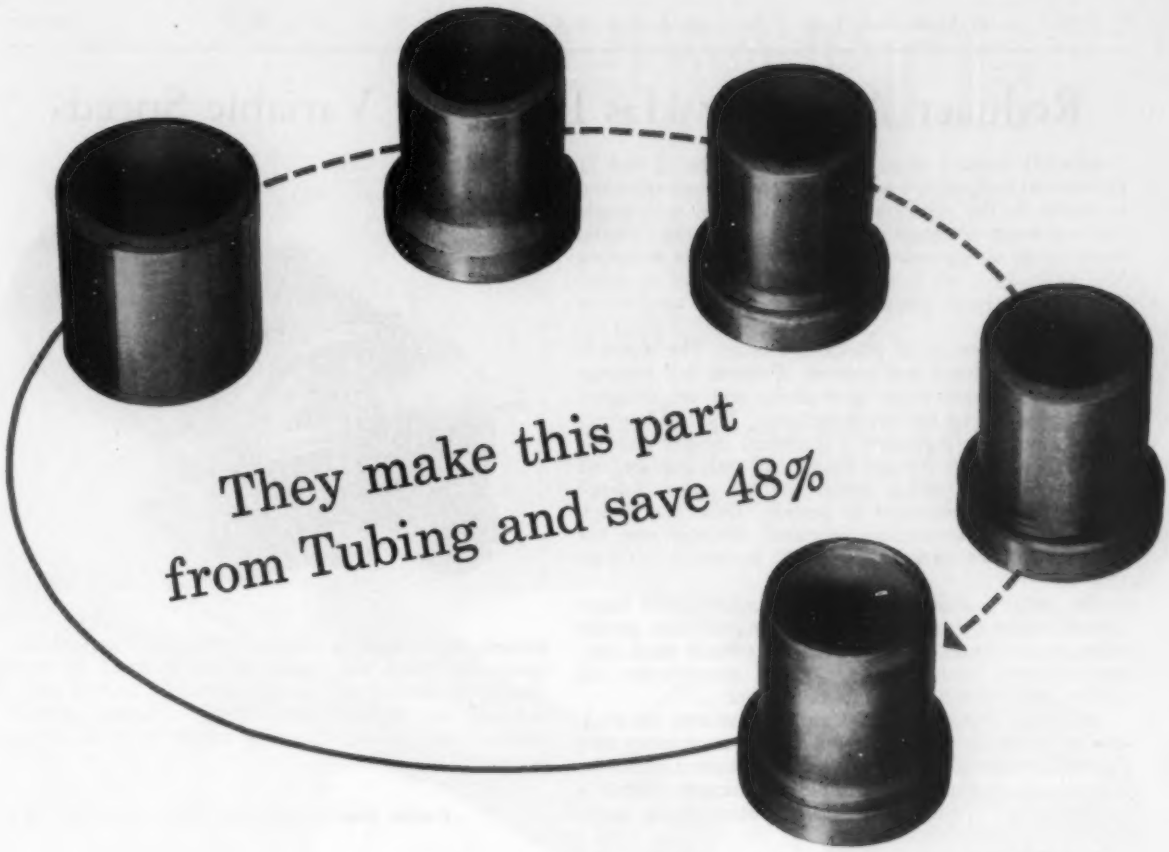
These capacitors are said to serve functions heretofore limited to mica types. They are based on ceramic developments by French engineers and scientists and provide complete independence from imported mica or other strategic materials. "Series HP" capacitors are particularly suitable for transmitting as well as industrial electronics applications. Thousands of these units have been in use for years in Europe and even under the gruelling climatic conditions found in Indo-China. The USA manufacturer has an exclusive license to make such capacitors in this country.

In both disk ("double-saucer") and cylindrical ("tubular") ceramic dielectric bodies, the new units are great space and weight-savers, with reductions from 50 to 90 percent compared with corresponding mica units. The unique contours of the ceramic dielectric, together with metallized surfaces serving as capacitor plates, provide anti-corona design and high flashover voltages. The heavy connections through large silver-plated surface areas provide for high currents.

Other features are: ease of mounting; ease of connecting in series or parallel; very low inductance connections; exceptional immunity to humidity, heat, cold, atmospheric pressure; wide range of designs, sizes, capacitance values and operating voltages, costs fully competitive with comparable mica units of similar designs.

Aerovox Corp., New Bedford, Mass.

CONTINUED ON PAGE 224



This part used to be made out of solid bar stock on a screw machine. Costly? You bet. 12½ cents each. Lots of expensive machining. Lots of metal wasted to make a hole.

Now, Northwestern Corporation, Morris, Ill., makes it out of tubing. ELECTRUNITE Mechanical Tubing, 1½ O.D. x 11 gage. The customer gets it in 14-foot lengths, cuts it off into 2" lengths.

Next, the tubes are formed in a series of dies. Pretty drastic reductions, but the ELECTRUNITE Tubing can take it. Then they're machine finished in one operation.

The result: Each part now costs only 6½ cents. Multiply that by several million parts a year the manufacturer produces and you come up with a sizable saving.

Unusual, you say? Not at all. Republic has helped a lot of manufacturers cut costs drastically by helping them design with Republic ELECTRUNITE Tubing. A call to your nearest Republic Sales office will bring you all the facts.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
222 E. 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Republic
REPUBLIC STEEL
ELECTRUNITE TUBING

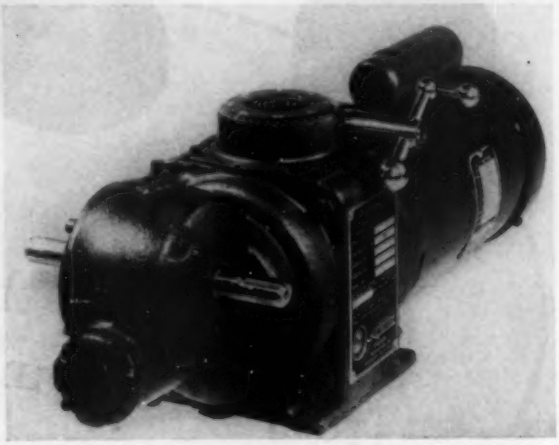
Reducer Assembly Has Infinitely Variable Speeds

Infinitely variable speed transmissions in the 1/6 and 1/4 hp sizes can be furnished with double output shaft extension as shown in the photograph or can be had with single shaft extension, horizontal or vertical, up and down. Several worm ratios are provided in this new assembly including 5:1, 12:1, 23:1, 45:1, and 60:1. This is said to result in a wide range of speeds, from 550 rpm to zero, to 10 rpm to zero.

The worm gear is of phosphor bronze. The worm is alloy steel, hardened and ground. Oversize ball bearings support worm and worm gear shafts and are designed to take heavy thrust and overhung loads. The ball bearings replace sleeve bearings used in the worm reducer that this new unit replaces. Spring loaded oil seals replace felt seals used on the earlier model and the center distance between shafts is increased 60 percent. These new design factors provide substantially increased efficiency over the earlier model, an increase of over 15 percent in the high ratios.

The entire assembly of reducer, variable speed transmission and motor is mounted with only four bolts, greatly reducing installation costs and making a much more compact assembly than if separate motor, transmission and reducer units were to be coupled together.

All speeds, from any desired maximum to zero, are available at a turn of the hand-wheel. The micrometer type control shown in the photograph is standard with the transmission and makes it possible to accurately reset to a predetermined speed. Other characteristics of the transmission include built-in overload protection, "straight line" speed adjustment with equal changes in speed for equal changes in the dial setting, wide choice of built-in motors including an explosion-proof design. Various types of controls are available, including remote electrical, remote pneumatic and hydraulic.



Graham Transmissions, Inc., Menomonee Falls, Wis.

High Output, Self-Generating Accelerometer

A highly compact self-generating accelerometer has been developed to determine frequency and amplitude at high voltage. Despite its small size, comparable to that of a walnut, the unit provides power output as high as two volts, without external excitation. The accelerometer's sensitivity is as low as ±0.003G, and frequency response is from two to 350 cycles per second. The unit is said to operate with extreme accuracy at temperatures up to 550 F.

The new unit is produced in a wide range of ratings. It can be used for many types of impact acceleration studies, vibration analysis and a wide range of other applications for aircraft, guided missiles and general industry.

General Scientific Corp., Los Angeles, Calif.

A NEW THICKNESS TESTER is a magnetic instrument similar in size and shape to the familiar automobile tire gauge. When the magnetic end is applied vertically to the surface to be tested and slowly pulled away, a calibrated inner stem appears. The distance the stem travels before the magnet releases itself from the surface is a measure of the thickness of the coating. The gage will test the thickness of electroplated cadmium, copper, brass, silver, zinc, tin, lead, nickel, zinc-tin and lead-tin alloys on steel, as well as hot-dipped tin and zinc. It is ideal for testing the thickness of paint, plastic lamination, enamel and lacquer coatings on steel. It will test thickness from 0.0001 in. to 0.015 in. Platers Research Corp., 59 E. 4 St., New York 3, N. Y.

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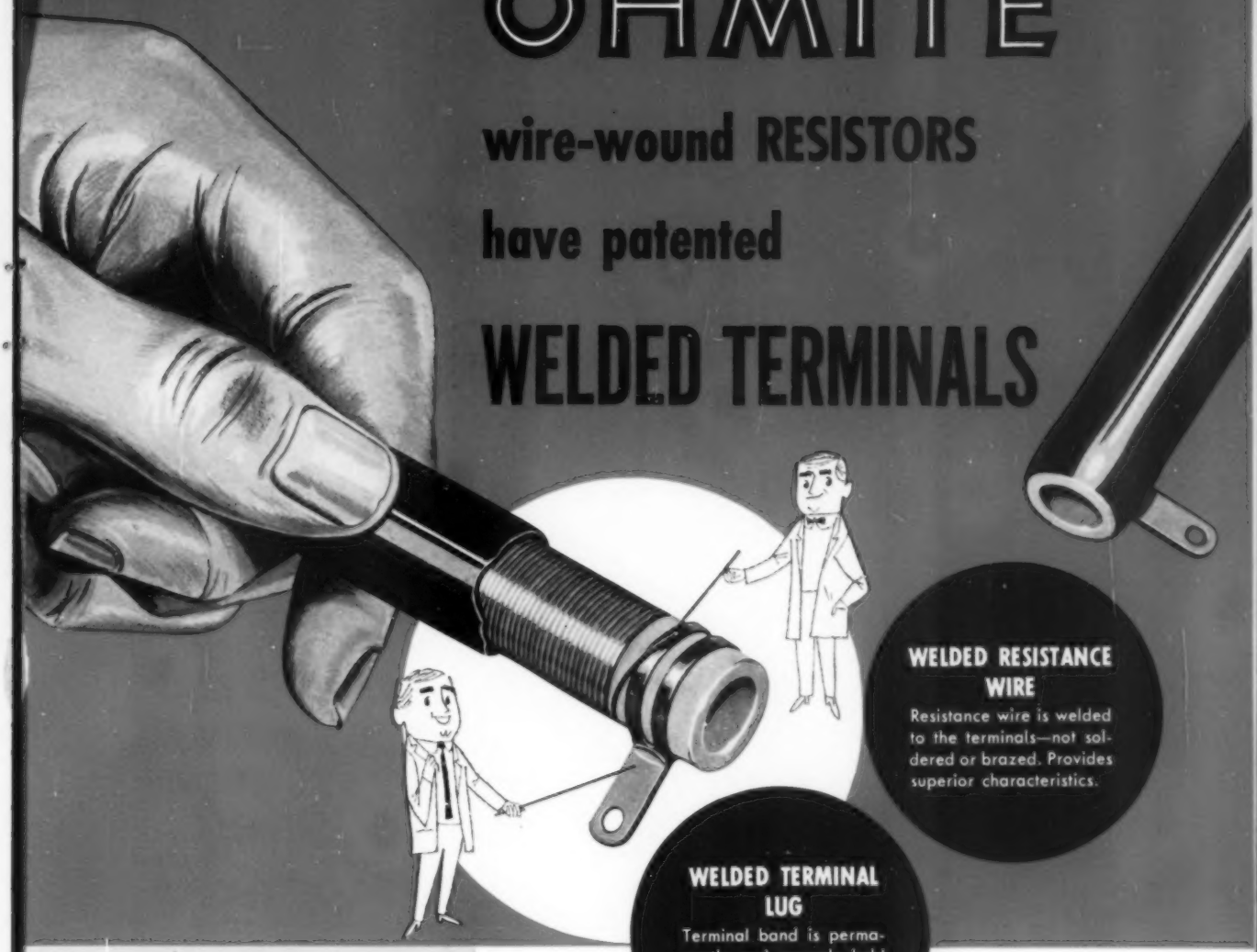
OHMITE®

wire-wound RESISTORS have patented WELDED TERMINALS



WELDED RESISTANCE WIRE
Resistance wire is welded to the terminals—not soldered or brazed. Provides superior characteristics.

WELDED TERMINAL LUG
Terminal band is permanently and securely held around the resistor tube by welding.

PATENTED WELDING PROCESS
Assures permanent terminal connections, unaffected by vibration or high temperatures.

STABLE ELECTRICAL CONNECTIONS
Extremely important in eliminating noise in audio circuits or instability in other highly sensitive circuits.

HIGH-STRENGTH ALLOY TERMINALS
High strength and properly related expansion coefficients keep terminals firmly anchored and prevent cracking of the enamel.

PROVED IN YEARS OF SERVICE
For more than ten years, millions of these resistors have proved their reliability under the toughest service.

Ohmite resistors provide other important advantages, too —a superior vitreous-enamel covering, which holds the windings rigidly in place, preventing "hot spots" and protecting the winding from moisture and fumes; strong ceramic core that is unaffected by cold, heat, fumes, or high humidity; and hot tinned terminal lugs for ease in soldering. For unfailing dependability, specify Ohmite resistors.

OHMITE
MANUFACTURING COMPANY
3611 Howard Street, Skokie, Ill.
(Suburb of Chicago)

Write on Company Letterhead for Catalog and Engineering Manual No. 40

OHMITE® offers an unusually complete line of MIL TYPE RHEOSTATS AND RESISTORS

MIL-R-22A RHEOSTATS

Ohmite can furnish rheostats to meet MIL-R-22A requirements in each of the 26 type designations. These severe requirements again prove the dependability of Ohmite rheostats. All-ceramic construction, close control, and smooth operation insure years of trouble-free service. It will pay you to standardize on Ohmite rheostats.

MIL-R-26B wire-wound RESISTORS

Ohmite offers an unusually complete line of tab-terminal, ferrule-terminal, axial-terminal tubular resistors, and tab-terminal, flat type resistors that meet the most rigid requirements (char. "G," "J," and "F") of MIL-R-26B. Ohmite offers 33 of the 38 resistor styles listed in MIL-R-26B, in a complete range of resistance values.

OHMITE®

FIRST IN RESISTANCE PRODUCTS

OHMITE MANUFACTURING COMPANY, 3611 Howard Street, Skokie, Illinois (Suburb of Chicago)

High-strength aluminum-alloy nuts meet AN steel nut tensile loads. Nylon locking inserts guarantee reusability through 50 on-off cycles.

Approved for use on Air Force, Army and Navy aircraft, the new ESNA Blue "J's" are lighter than any other self-locking nuts of equivalent strength.

Intended for use with AN steel bolts and lubricated to minimize thread wear, the new ESNA Blue "J's" provide a smoothly uniform torque-tension relationship and forestall thread galling. They accomplish maximum fastener weight savings without sacrificing strength. Completely interchangeable with equivalent steel parts.

Briefly, here's what we offer:

STRENGTH . . . *Tested and approved to AN tensile strength specifications for steel nuts of the same size.*

AVAILABILITY . . . *sizes #6 through ¼" in designs that offer every important standard hex and anchor configuration including one lug, two lug, and corner types, floaters and gang channel.*

NYLON INSERTS . . . *in all anchor and channel types provide extended reusability — assuring elimination of maintenance problems created by replacement of "fixed" or inaccessible fasteners which are riveted or welded to the structure (hex nuts available with fiber or nylon inserts) and assuring the vibrationproof holding power, reusability and self-locking action provided in all ELASTIC STOP® nuts.*

ELASTIC STOP NUT CORPORATION OF AMERICA

Mail Coupon for Design Information

Elastic Stop Nut Corporation of America
Dept. N46-72, 2330 Vauxhall Road, Union, New Jersey
Please send me the following free fastening information:

☐ Details on ESNA Blue "J's"
☐ ELASTIC STOP nut bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

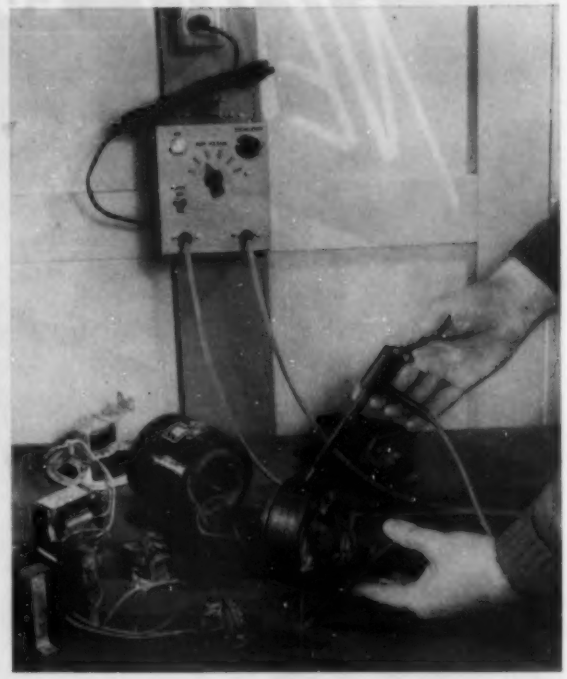
Name_____

Firm_____

Street_____

City_____ Zone_____ State_____

Insulation Tester Signals With Light and Sound

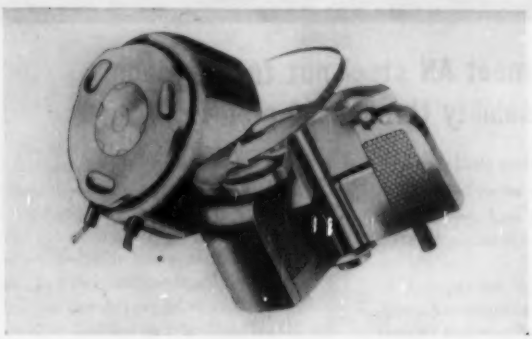


Both a buzzer and a red light indicate when an insulation breakdown or ground is found in electrical components tested with the "Model 101" high voltage tester, permitting an inspector to watch his work at all times. Repetitive testing on a production basis is said to be easier and faster as less attention is directed to the tester, which does not arc-burn plated or polished parts.

The unit is equipped with push-button testing prods which retract for safety into phenolic housings that are small and light enough for women to handle conveniently. Flexible test leads are anchored to the unit with bayonet connectors to permit easy replacement without disassembling the tester.

The device has an on-off switch, a warning pilot light, and pointer knob for selecting any of six common testing voltages between 500 and 2500 a-c. Weighing 5¾ lb and operating from a 115 v, 60 cycle outlet, the tester is easily shifted between inspection stations where it occupies a 4 x 5 in. bench space.

Slaughter Co., 1700 Nicklin Ave., Piqua 4, Ohio



Rotary Solenoid

This new model of rotary solenoid employs the same principal of operation as the six other basic models in current production. The magnetic pull moves an armature along the solenoid axis. This linear action is efficiently converted into rotary motion by means of ball bearings on inclined races. The resulting rotary snap-action power can be efficiently harnessed with a minimum of linkages.

The new "Model BD4" rotary solenoid is $1\frac{9}{16}$-in. dia. and is available in 25, 35, 45, 67½, and 95 deg of rotation either clockwise or counterclockwise, with starting torques up to 5.39 lb-in.

G. H. Leland, Inc., Dayton 2, Ohio

High-Temperature Servo Motors

These servo motors, designed for elevated temperatures, can operate in equipment where they are likely to encounter service temperatures as high as 320 F. Included among these new models are two designated as BuOrd Mark VII and Mark VIII. There are also some fifteen other design variations available, with a wide choice of either plain or pinion-type shafts.

These servo units have high torque to inertia ratios and are said to be fully qualified to satisfy humidity, saltspray and fungus resistance tests prescribed by the armed forces. Delivery takes 30 to 45 days.

American Electronic, Inc., 9503 W. Jefferson Blvd., Culver City, Calif.

CONTINUED ON PAGE 224

DAMCO Selects WICHITA CLUTCHES for NEW SHOT HOLE RIG!

After thoroughly checking all available clutches, Drilling Accessory and Manufacturing Company, Inc., of Dallas, selected WICHITA Air-Tube Disc Clutches for their new AR-2000 Portable Drilling Unit. WICHITA CLUTCHES were selected for their compact, rugged construction and for their smoother, safer and faster operation. This rig, designed by DAMCO Engineers primarily for FAST SEISMOGRAPH SHOT HOLE, BLAST HOLE, WATER WELL, or CORE DRILLING, is the very FIRST rig of this type *to use air clutches as standard equipment*. Two 14-inch double plate WICHITA Air-Tube Clutches are used in the drums and the air for their operation comes from a compressor mounted under the truck hood.

The above photo shows the convenient controls, the platform on which the operator stands, the hydraulic pull down, and the two drums in which the WICHITA 14-inch double plate Air-Tube Disc Clutches are located

The smooth, economical operation of this all new DAMCO AR-2000 Rig is so outstanding DAMCO has standardized on WICHITA Clutches: *PROOF AGAIN THAT WICHITA CLUTCHES ARE USED BY THOSE WHO WANT THE VERY BEST.*

WICHITA Tools
FOUNDRY & MACHINE CO., INC.
WICHITA FALLS, TEXAS, U.S.A.

FOR MORE WICHITA CLUTCH DETAILS SEE YOUR NEAREST WICHITA ENGINEER

Brehm-Lahser, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co. (Main Office) West Hartford, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Oklahoma
Dominion Power Press Equipment, Ltd., Toronto, Ontario, Canada
Oil Field Motor Service, Alice, Texas
Hunt Tool Co., Houston, Texas
Industrial Air Controls Co., Ft. Worth, Texas
Denigan Tool & Supply Co., Odessa, Texas

PEERLESS PROVIDES *"Private"* MOTOR FACILITIES

* *Original Equipment Manufacturer*

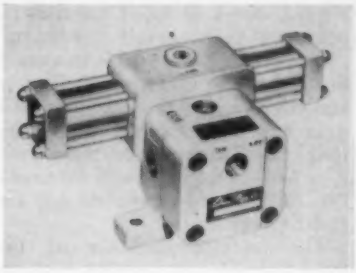
● When you're trying to make a standard motor fit a custom job—when you need special characteristics in your motors —when you wish you had your own motor department—what you really need is Peerless. Let me tell you about Peerless — Let's say you require a motor with special characteristics — more torque, higher speeds, or smaller dimensions—talk it over with our engineers. Chances are the problem won't look so tough to us since we've been building special motors for 60 years. We'll solve your "spec" problem. Then, together, we'll tackle production questions and set delivery dates to meet your needs. This integration of facilities and thinking produces such outstanding motors that we call them Gold Seal Motors. You may wish to talk to some of the people that use them. Ask us and we'll refer you. To get started, call Peerless. Ask for me if you like. I'll see that you talk to the engineer who can help you most. No obligation to you.

You can have the motor you want, custom designed for your product, at a competitive price. We build them . . . Peerless Gold Seal Motors.

Ralph Krochle
President

THE PEERLESS ELECTRIC COMPANY · WEST MARKET ST., WARREN, OHIO

MOTORS FANS BLOWERS



Disc-Type Power-Operated Valves

Designed for actuating remotely located or automatically operated cylinders, two new disc-type power-operated valves have a "free-floating" piston movement, said to eliminate alignment problems.

The design also incorporates a floating piston bar, pilot valves, power return to all positions, use of non-corrosive materials. It is easily accessible for ease of inspection.

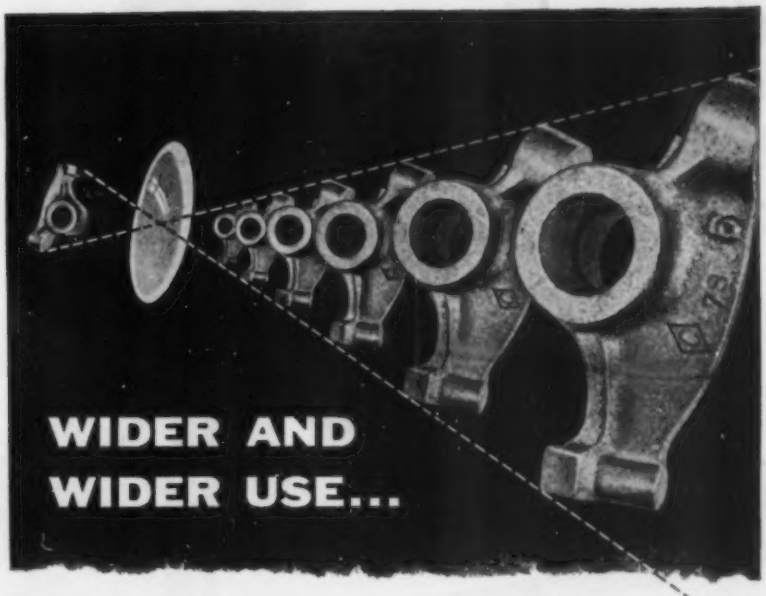
Solenoid-operated power valves are available as complete package units. These new components are built in sizes from $\frac{3}{8}$ to $1\frac{1}{4}$-in. standard pipe connections.

Ledeen Mfg. Co., 1600 *S. San Pedro St., Los Angeles* 15, *Calif.*

Molded Insulation For Pipe Fittings

Manufactured in preformed halves, this new glass fiber pipe fitting insulation is light in weight, easy to apply and it may be used on moderate low-temperature lines and on piping heated as high as to 450 F.

The insulation is accurately molded to fit screwed and butt-welded fittings. The inside conforms to the contour of the fitting and the outside forms a smooth, even curved surface which may be painted, or covered with canvas, vapor barrier mastic or cement. The two halves may be



PEARLITIC MALLEABLE CASTINGS as engineers see its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings – particularly as a replacement for forgings, stampings and weldments – where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations.

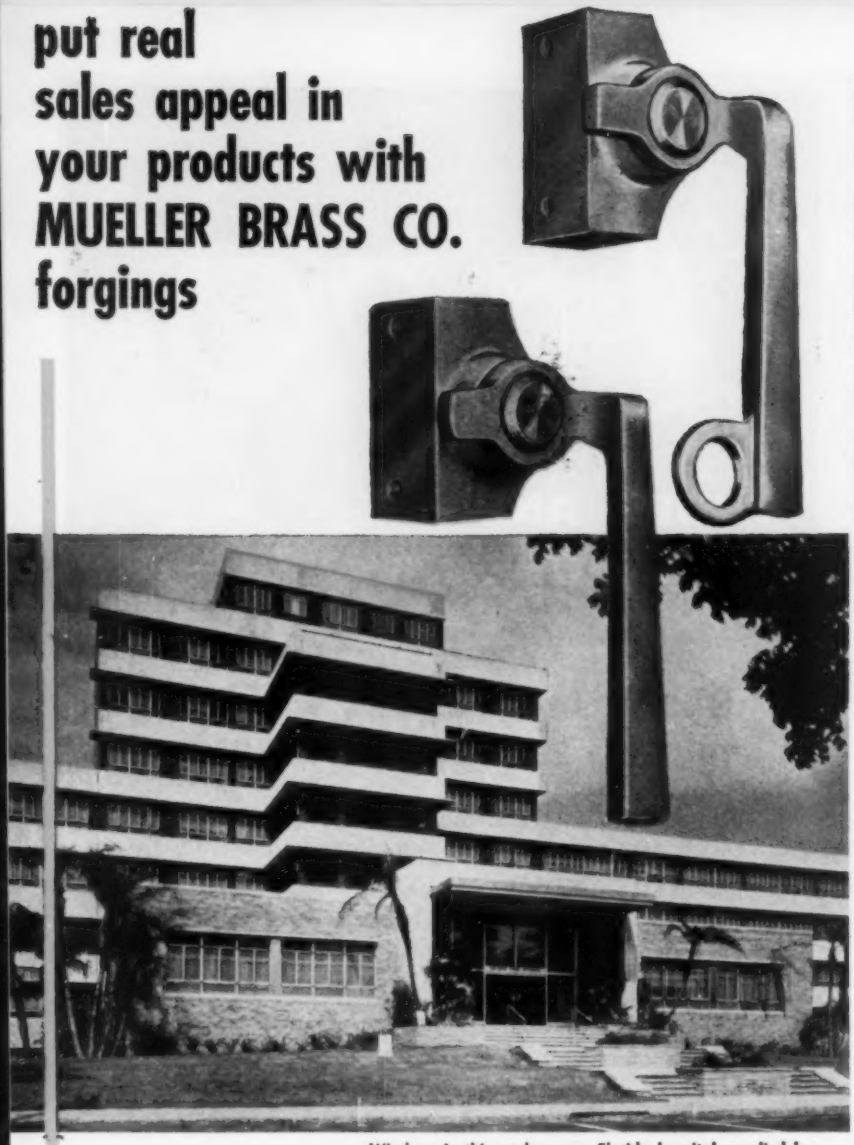
A-9277

NATIONAL MALLEABLE AND STEEL CASTINGS

COMPANY
Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

put real sales appeal in your products with MUELLER BRASS CO. forgings



Windows in this modern new Florida hospital supplied by Valley Metal Products Co.—subsidiary, Mueller Brass Co.

The aluminum hardware used on all the windows in this modern hospital is a good example of the sales appeal that can be built into a product with Mueller Brass Co. forgings. These forgings are smart in design, practical in operation, and low in cost. They can also be produced in natural bronze or chrome finish depending on the desires of the architect or builder.

All Mueller Brass Co. forgings have a dense, close-grained structure with a high tensile strength. Weight savings up to 40% are possible in the design of parts because of the close tolerances to which they can be produced. Less scrap and longer tool life result from the easy machinability of forged parts. Mueller Brass Co. is completely equipped to produce brass, bronze or aluminum forgings to your specifications. For complete details, write us today.

MUELLER BRASS CO.

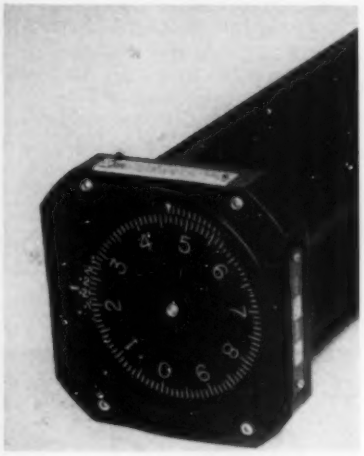
PORT HURON 17, MICHIGAN

stapled, wired or taped together for permanent or removable attachment.

The product is available in sizes to fit standard cast iron screwed ells, tees, and other fittings for pipe sizes from ½ to 8-in. and standard butt-welded long radius fittings for pipes from 2 to 8-in. in size. Screwed tee insulation may be used to insulate gate and globe valves.

The uniform thickness of this molded insulation together with its high insulating efficiency minimizes heat loss. It is stated that it will not settle, flake, chip or crack, is not damaged by moisture and will not corrode piping.

Owens-Corning Fiberglas Corp., Toledo 1, Ohio



Two New Types Of Data Repeaters

These data repeaters are a result of an extensive research program at the Massachusetts Institute of Technology. The equipment consists of two major parts: a precision mechanical unit packaged for standard aircraft panel mounting, and an appropriate amplifier. The fundamental purpose of the equipment is to repeat data which is available either as a voltage or as a mechanical shaft position to an indicator which is capable of being photographed. An essential feature is that the equipment accomplishes its task with a reported high degree of accuracy.

Two basic types of repeaters are available: the synchro data repeater which accepts a shaft position as the input signal, and the helipot data repeater which accepts a voltage (400 cps suppressed carrier or dx) as the input signal. The synchro data re-

Announcing a new Koppers plastic— "Fibertuff" Polystyrene

It's reinforced with glass fibres yet it is easy to mold

● New "Fibertuff" Polystyrene contains thousands of glass fibers. When the polystyrene is heated and injected into molds, these fibers break up, so that the compound flows smoothly through the injection nozzle—to fill the entire mold. When the material sets, the glass fibers reinforce the polystyrene. As a result "Fibertuff" Polystyrene products are strong, rigid and maintain full mold dimensions.

"Fibertuff" Polystyrene is molded like any other polystyrene. Special injection nozzles and molds are not required—and scrap can be ground up and re-used.

This new reinforced thermoplastic is finding many uses. One molder, for example, is using "Fibertuff" Polystyrene to manufacture tape recorder reels. The new polystyrene reels weigh 50% less than the metal one previously in use. They do not warp or dent, and will not scrape the tape edges. "Fibertuff" Polystyrene can be used in heater fans, battery cases and radio cabinets—wherever strength, heat resistance, and dimensional stability are important.

For more detailed information about the properties and molding characteristics of "Fibertuff" Polystyrene write to us today.

Koppers Plastics Make Many Products Better and Many Better Products Possible.

KOPPERS®

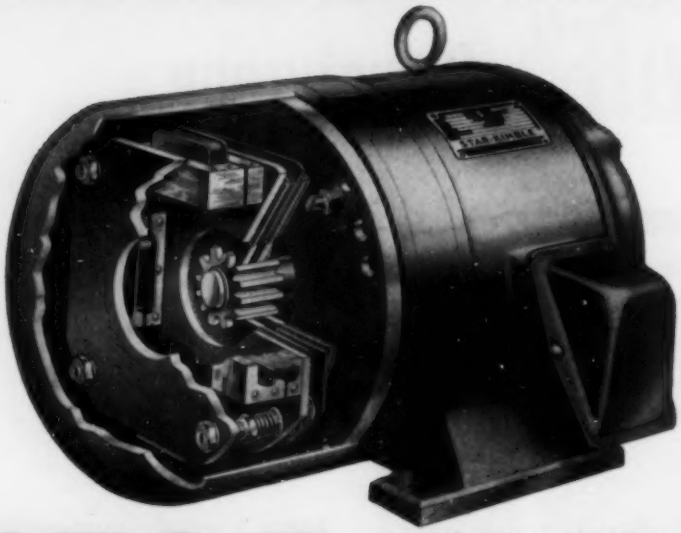
Koppers Plastics

★ Guaranteed by Good Housekeeping

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-74, Pittsburgh 19, Pennsylvania

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · ATLANTA · CHICAGO · DETROIT · LOS ANGELES

START QUICKLY, SMOOTHLY, without BRAKE DRAG!



STOP FROM FULL SPEED IN A SPLIT SECOND!

WITH STAR-KIMBLE BRAKEMOTORS

Time from full speed to standstill can be as short as *one-fifth of a second* with a Star-Kimble Brakemotor — the *extra-large* brakelining area makes possible these *extra-fast* stops of motor and connected load.

Starting of the motor is fast and smooth, too. The small air gap results in instantaneous release of the brake when the motor current is switched on. No brake drag to impede acceleration.

These cycles of split-second stops and smooth starts can be repeated millions of times — that's proved by the experience of user after user of Star-Kimble motors, even in the severest types of service. In reversing service, a Brakemotor can make four times as many starts a minute as a motor which is reversed by plugging.

Every Star-Kimble Brakemotor is an integral, space-saving unit — with motor and brake designed and built together to work together. A single manufacturer — undivided responsibility.

For the full story, write for Bulletin B-501-A

STAR-KIMBLE

MOTOR DIVISION OF

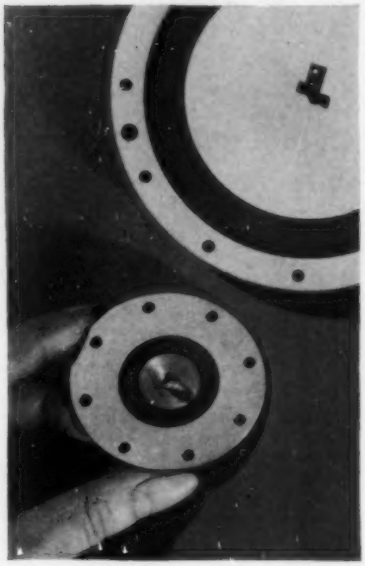
MIEHLE PRINTING PRESS AND MFG. CO.

211 Bloomfield Ave. **Bloomfield, N. J.**

peater uses a dual synchro data system, a three-watt, two-phase, induction motor, and a coupled inertia damper for servo compensation. The dual synchro system provides for two modes of operation—"fine" and "coarse." In the fine mode, the synchros used are geared up from the input shaft and result in a steady state accuracy of ± 0.05 deg. The coarse mode is provided to eliminate the ambiguous nulls which result from the fine synchro gearing. An electronic switching arrangement is provided in the amplifier to automatically select the operating mode.

The helipot data repeater utilizes a ten-turn precision helipot as the servo feedback element. The input signal may be either 400 cps suppressed carrier or dc, provided that the correct amplifier is used.

Midwestern Geophysical Lab., Tulsa, Okla.



Thin Diaphragm For Extreme Conditions

A diaphragm sensitive to minute changes in air pressure and which register these changes by flexing essentially the same few thousands of an inch at both —30 C and at 110 C has been developed. The diaphragm is also reported to be air-tight, not absorb moisture, and to be able to withstand vibration and shock common to airborne apparatus. In addition, production models of the diaphragm possess a high degree of uniformity.

The new component is made of one of the silicone rubbers. Methods have been worked out for molding mem-

Specify

GITS *Unit* SEAL

Result:

Economy

"Economy... counts not in savings but in selection."—*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

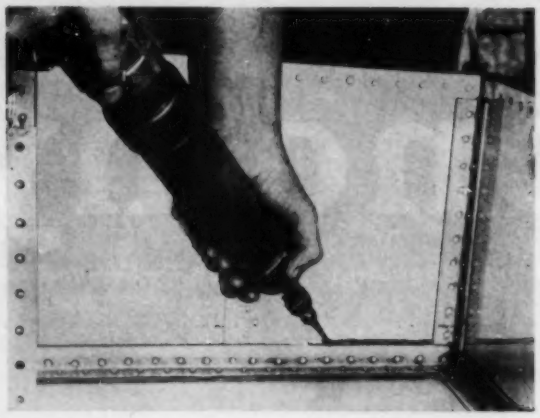
Write Today For FREE Illustrated Brochure, or send us your seal problem. Our experienced engineering staff is at your service.

*Cartridge Seal . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Avenue — Chicago 23, Illinois

SPECIFY *Thiokol*® LIQUID POLYMER LP-2
for CRITICAL SEALING JOBS



Thiokol **LIQUID POLYMER LP-2 IS A SOLVENTLESS LIQUID THAT CONVERTS TO A RUBBER AT ROOM TEMPERATURE WITHOUT SHRINKAGE.**

Compounded and cured, "Thiokol" LP-2 has the following desirable combination of properties:

- TENACIOUS ADHESION TO GLASS, METALS, PLASTICS, WOOD AND LEATHER.
- INERTNESS TO OILS, MOST SOLVENTS, WATER, MILD ACIDS AND ALKALIES.
- IMPERMEABILITY TO GASES AND MOISTURE.
- INERTNESS TO OZONE, SUNLIGHT AND AGING.
- FLEXIBILITY AT EXTREME LOW TEMPERATURES.
- TOUGHNESS AND RESILIENCE.

Because of these properties, "Thiokol" LP-2 compounds are specified for sealing airplane wing tanks as pictured. It provides the required combination of properties and dependability in this critical application.

There are many other important sealing applications where "Thiokol" LP-2 provides the required combination of properties... sealing pressurized aircraft cabins and cold room windows... potting electrical connectors, transformers and wires... and bonding various combinations of metals, plastics, glass, wood and leather.

Perhaps "Thiokol" LIQUID POLYMER LP-2 can do an outstanding job for you. For technical information and samples contact:

Thiokol Chemical Corporation supplies "Thiokol" LP-2 only as a raw material. We will gladly indicate sources of supply to end-users.

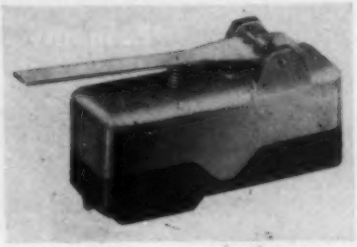
Thiokol Chemical Corporation

784 NORTH CLINTON AVENUE, TRENTON 7, NEW JERSEY

branes of silicone rubber as thin as 0.005 in. to aluminum discs repetitively and while meeting all requirements. The process is a precision one, requiring accurate control of process temperatures and times, curing cycle rates, and cleanliness.

These diaphragms have already been applied to airborne equipment and to power switchgear.

Westinghouse Electric Corp.,
401 Liberty Ave.,
Box 2278, Pittsburgh 30, Pa.



Snap-Acting Switch Has Hinged Leaf Actuator

A snap-action switch for use where low operating force is desirable is provided in a new design which uses a rigid lever arm pivoted on a bearing pin set in supports integral with the molded cover of the switch. The actuating arm can be furnished in any desired length and with special bends. The actuator can be modified, by eliminating the coil spring, to permit operation at forces down to 15 g. Because of the long overtravel provided by the lever-arm actuator, this switch is suitable for use in cam or slide-operated controls. The switch carries a current rating of 15 amp at 125 volts a-c.

Unimax Switch Div.,
The W. L. Maxson Corp.,
460 W. 34 St., New York 1, N. Y.

Voltmeter For Panel Mounting

This miniaturized, panel-mounting version of the familiar laboratory voltmeter requires the same panel area as a standard 3½-in. meter and has a depth of only 4¼ in. It is said to give an equipment designer all the advantages of electronic measurement of a-c voltages without exceeding the space allotted a standard meter.

The new voltmeter is designed specifically for incorporation in complex production test equipment as well as lightweight, airborne or portable elec-

CLARE

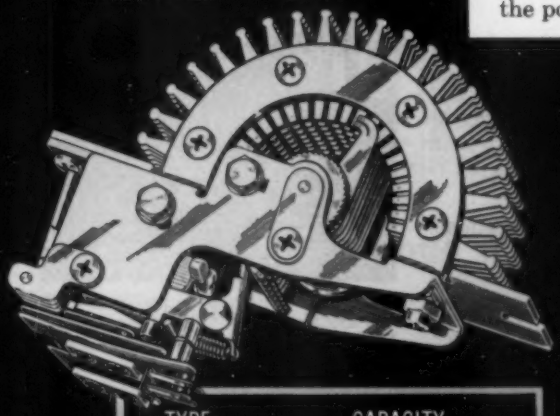
Stepping Switches meet wide range of circuit selection and control problems

CLARE Spring-Driven Stepping Switches are uniselectors, or rotary switches, for completing, interrupting, or changing the connections in, a succession of electric circuits in response to momentary impulses of current.

The switch consists essentially of one or more wiper springs, fixed to a shaft, rotated by a pawl and ratchet mechanism, actuated by an electro-magnet which responds to current impulses. These impulses may be from an external pulsing device or produced by the switch itself, by interrupter springs operated by the magnet armature. Additional contacts may be included in this spring assembly to perform other desired control or signal functions. Remote control operation speed is 30 steps per second maximum. Automatic operation may be as high as 60 steps per second on 48 volts dc or 115 volts ac (with rectifier).

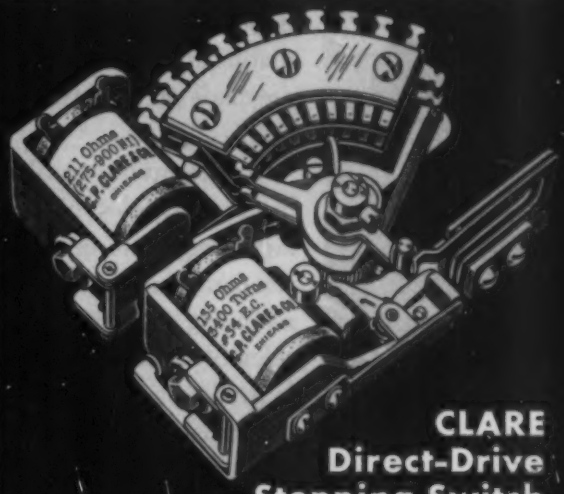
CLARE Direct-Drive Stepping Switches are operated as the stepping magnet drives the pawl into the ratchet to move wiper assembly. Wipers are held in place by a detent when magnet is de-energized. Pawl is returned to normal by a spring. Circuit may be held closed for any desired time after final step. Pawl is normally disengaged from ratchet, and wiper assembly can be returned to normal by a reset magnet. Maximum operating speed: 35 steps p. s. under ideal pulsing conditions. Release time is 0.030 to 0.070 second depending on voltage and the position from which wipers are released.

CLARE Spring-Driven Stepping Switch



TYPE	CAPACITY
20	1 to 8 levels, 20-point
26	1 to 10 levels, 26-point
40	1 to 4 levels, 40-point
52	1 to 5 levels, 52-point

A versatile, high-speed switch for—
Selecting desired point of a series
Sequence control • Counting and totalizing
Monitoring



CLARE Direct-Drive Stepping Switch

Designed for such control functions as—
Selecting one circuit path out of ten
Consecutively performing operations in separate individual circuits

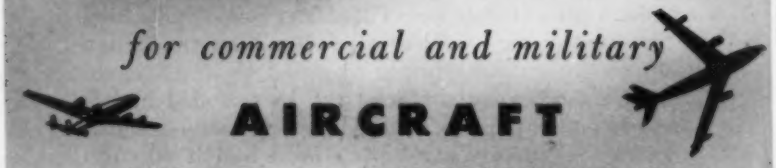
Send for Engineering Bulletin No. 103 for a discussion of stepping switch operation and applications. For full technical data ask for Engineering Bulletin No. 101. Address C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY

CLARE RELAYS

Announcing

COHRLASTIC SEALS

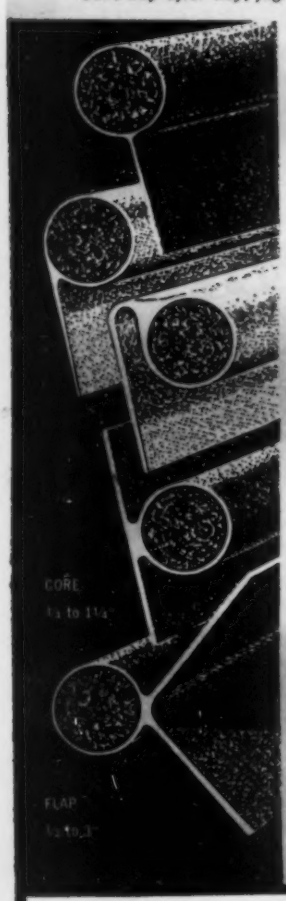
for commercial and military



AIRCRAFT

Revolutionary, new, tough silicone rubber seals with soft, flexible, resilient sponge cores and abrasion-resistant, fabric sheath, molded in one solid piece, now available for the first time.

Eighty lbs tear strength; 15000 psi tensile strength. Eliminates 300 rivets per 100 feet of seal. Non-sticking; low compression set; non-crushable; non-shatterable, at any temperature from 100 below to 500 above. Reduces UR's day after day, flight after flight.



THE AIRCRAFT industry has long wanted a superior type of sealing strip for doors and openings on fighters, bombers, transports — pressurized planes of all kinds.

Entry doors, hatches, bomb-bay doors, underwing store areas — irregular mating surfaces of every character — are made pressure tight when this seal is applied.

Unlike ordinary rubber that becomes brittle and lifeless in the high altitude flight temperatures, COHRLASTIC seals stand intense heat and cold and take the slamming and banging received on the assembly floor, and rough treatment from flight and ground crews, maintenance and operations people.

Available in a wide variety of designs and materials. Samples, quotations and literature on request.

COHRLASTIC

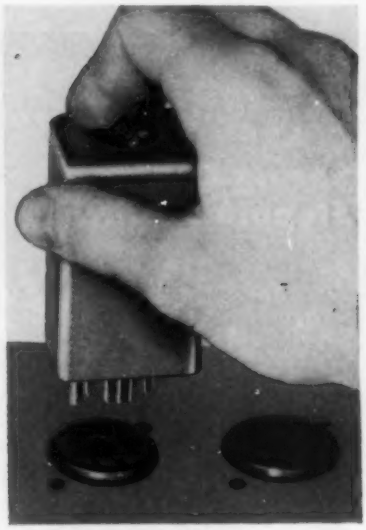
408 EAST ST. • NEW HAVEN, CONN.

PRODUCT OF THE Connecticut HARD RUBBER COMPANY

MANUFACTURERS OF SILICONE RUBBER COATED FABRICS REINFORCED WITH FIBERGLAS, NYLON, DACRON AND ORLON FOR SPECIFIC APPLICATIONS. MOLDED SHEETS, CUSTOM PARTS, EXTRUSIONS, PRESSURE-SENSITIVE TAPES, HIGH TEMPERATURE DE-ICING SYSTEMS, NON-LINEAR MOUNTS, CONDUCTIVE GASKETS.

tronic equipment. It will no longer be necessary to provide external meter test jacks for high impedance or low level measurements. Also, the confusion of multiple-scale instruments for single-scale requirements has been eliminated. Now the exact voltage scale can be built in at the time of design. The new unit is available with full-scale sensitivities ranging from 10 millivolts RMS to 300 RMS. With an input impedance of 1 megohm and an accuracy of 3 percent the meter can be used for measurements from 20 cps to 50,000 cps.

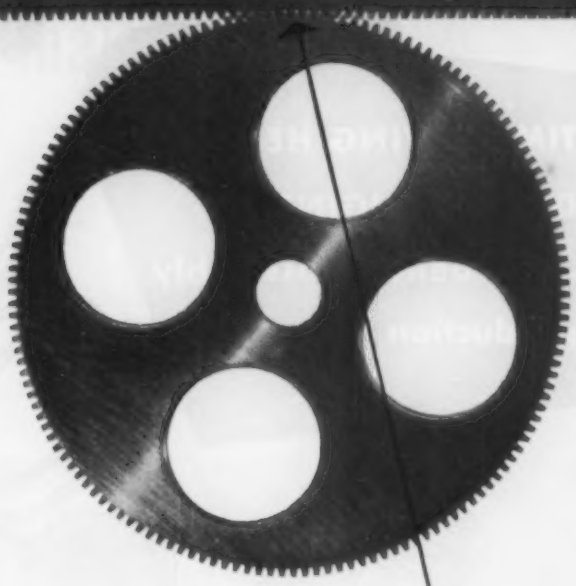
Trio Laboratories, Box 143, Wantagh, N. Y.



Plug-In Time-Delay Relay Uses Silicone Element

A new time delay relay combines the hydraulic-magnetic silicone operating principle with the convenience of plug-in construction. Compact, lightweight, and hermetically sealed against dust and moisture, with an inert gas fill optionally available, the relay is provided with standard delay periods from ¼ to 120 sec.

Other than the armature-and-switch contacts, there is only one moving part in the new relay—the movable iron core which is the complete time element. The core is hermetically sealed in a non-magnetic metal tube extending through and beyond a solenoid coil. When the coil is energized, the core is drawn into the magnetic field, but the silicone fluid surrounding the core slows its rate of travel hydraulically—providing time delay. Contacts are actuated by the increase



Why you can *reduce rejection losses* with a Kodak Conju-Gage Gear Checker

Why the composite check

In practice, the final test of gear quality is how the gear works in use. The composite check recommended in American Standard B6.11-1951 shows this conclusively by measuring displacement of the gear when run against a master of known accuracy. And it does it in one quick operation that checks combinations of as many as six types of errors.

Why the Conju-Gage Gear Checker

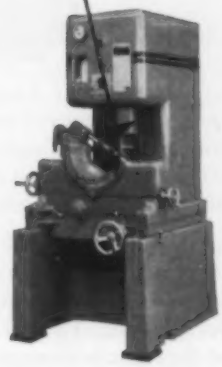
Since displacement represents the sum of both gear error and error in the master, the accuracy of the master used determines the precision of the composite check. The Kodak Conju-Gage Gear Checker uses a master of exceptional accuracy, the Conju-Gage Worm Section. Produced by thread grinding, its accuracy is not limited by the same manufacturing processes which limit accuracy in the gear itself.

To settle for masters of lesser accuracy is to rob yourself of "tenths"—to chance that tolerable error in a gear may coincide with error in the master to cause a needless rejection. Or that intolerable error in a gear may be cancelled by error in the master to pass a gear that will fail in use.

To reject every wrong gear is to guard the quality of your product. To pass every right gear is to reduce such rejection losses to a minimum.

To find out more about how a Kodak Conju-Gage Gear Checker can lower costs while maintaining required precision, send for your copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to

Special Products Sales Division
EASTMAN KODAK COMPANY, Rochester 4, N.Y.



The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 8U, for gears up to 8¼" pitch diameter. Smaller models are also available.

CONJU-GAGE INSTRUMENTATION

... a new way to check gear precision in action

To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak

YOU CAN MAKE important savings whenever you need bellows or bellows assemblies—by calling upon Fulton Sylphon or Bridgeport Thermostat.

Our bellows application engineers are ready to help make your design problems easier and your products better. They'll recommend the right bellows metal . . . stainless steel, brass, monel or nickel. They'll know the correct bellows charge for the job . . . volatiie liquid or gas. They'll help you in many more ways, to assure your having a bellows assembly exactly suited to your specifications. And, they're backed by half-a-century of experience, skilled production personnel and ample facilities—further assurance of time-and-money-savings for you.

Sylphon and Bridgeport bellows assemblies are used for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints and more applications.

Write for technical advice on your requirements. Ask for idea-filled Catalog NP-1400.

Robertshaw-Fulton
CONTROLS COMPANY

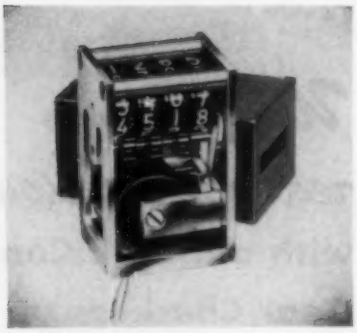
FULTON SYLPHON DIVISION
KNOXVILLE 1, TENNESSEE

BRIDGEPORT THERMOSTAT DIVISION
BRIDGEPORT 1, CONNECTICUT

in magnetic flux as the core touches the pole piece.

These new time delay relays are furnished with either octal-pin or solder-lug terminals for operation on 24 to 220 v, a-c, 12 to 125 v, d-c. Contact capacity is 3 amp at 120 a-c, or 1 amp at 50 d-c.

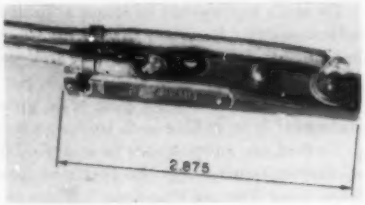
Heinemann Electric Co.,
725 Plum St., Trenton 2, N. J.



Miniature High-Speed Electro-Magnetic Counter

The balanced mechanism of a new electro-magnetic impulse counter is said to prevent miscounts due to shock or vibration, thus suiting it for use in aircraft and other mobile equipment. The new unit's four dials (non-reset) read up to 9999, and it is $1\frac{5}{8}$ x $1\frac{1}{32}$ x $\frac{57}{64}$ in. and weighs less than $1\frac{3}{4}$ oz. It counts at speeds up to 40 cycles per second, on actuation by interruption of a 28-v, d-c circuit.

Unimax Switch Div., W. L. Maxson Corp.,
460 W 34 St., New York 1, N. Y.



Structure Overheat Switch

This switch is actuated by heat from the surface to which it is attached and is designed for surface temperature up to 1750 F. In its original application, it served to close a circuit operating a warning device when the temperature approached the maximum allowable. High-temperature materials are used throughout and major com-

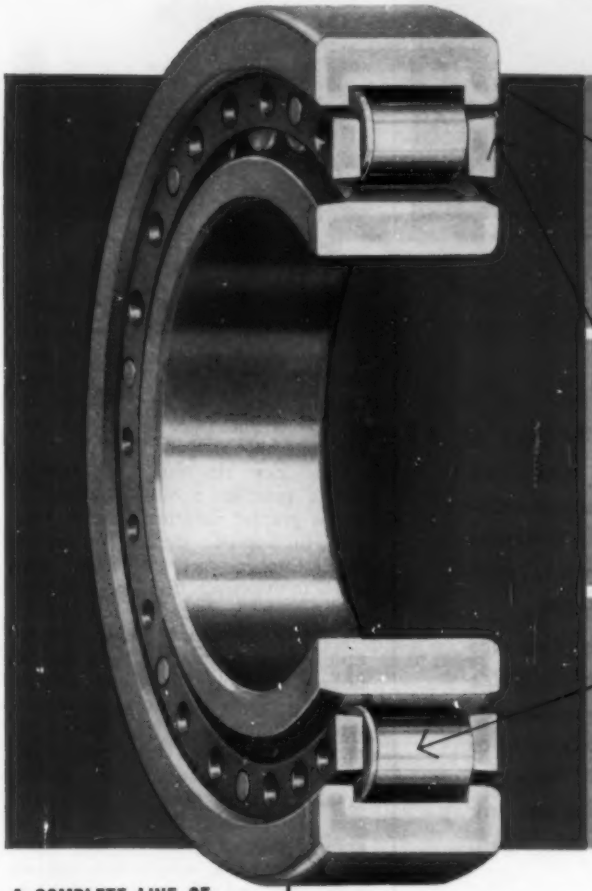
Here's why BOWER straight roller bearings can carry maximum loads—with less maintenance!

The important design features of Bower straight roller bearings shown on this page are just a few of the reasons why these bearings will operate efficiently and economically in your product. Consider these facts, too. Bower straight roller bearings incorporate highest quality materials and workmanship. They have proved themselves capable of standing up day in and day out under maximum loads—with little or no maintenance.

In fact, this is the reason why Bower straight roller bearings are used extensively by leading manufacturers in such fields as automotive, earthmoving, farm equipment and machine tool.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the blueprint stage.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN



● *TWO-LIP RACE INCREASES RIGIDITY.* These two shoulders, made parallel, are integral with the outer race. This provides a more rigid, durable construction. Rollers are kept in proper alignment at all times.

● *COMPOSITE STEEL CAGE DOES NOT CONTACT ROLLERS DURING NORMAL OPERATION,* thereby allowing free movement of the rollers between the races. Projections on the inner faces of the rings engage indentations on the roller ends preventing the rollers from dropping out of position when the separable race is removed.

● *PRECISION-BUILT ROLLERS AND RACES ARE MADE TO SUPPORT MAXIMUM RADIAL LOADS.* Only the highest grade steel-alloy is used, and rollers and races are precision ground to give quieter, smoother operation. Running clearance is built in at the time of manufacture.

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER

ROLLER BEARINGS

SPHER○HONED

Certified CYLINDER POWER

Testing Anker-Holth Hydraulic Cylinder to be used on a metal stretch forming press. Cylinder on test is 16" bore, 69½" stroke, for 3000 psi operating pressure. Tested at 4500 psi.

Thorough testing of Anker-Holth Cylinders assures you dependable power

● Every Anker-Holth Cylinder... large and small... is tested at 150% of working pressure with the latest completely-filtered testing equipment. Anker-Holth testing facilities include portable units such as the one shown... also stationary equipment for pressures up to 10,000 psi.

This is one of many safeguards in manufacturing to assure you top performance and dependability in Anker-Holth Cylinders. There's a type and size of cylinder to match *your* need. Anker-Holth engineering know-how is available to help solve your power motion problems. Call or write ANKER-HOLTH DIVISION of The Wellman Engineering Co., Dept. F-4, 2723 Conner St., Port Huron, Michigan.

FREE: *Bulletin on complete line of ANKER-HOLTH products.*

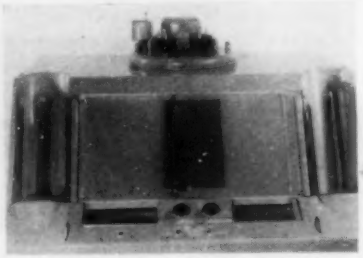
Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN

Division of THE WELLMAN ENGINEERING COMPANY

ponent parts are assembled by welding. Contacts are platinum—iridium alloy and insulation is mica. The calibration screw is stainless steel and provision is made for maintaining its setting under vibration.

The model shown is $2\frac{7}{8}$-in. long, $\frac{9}{16}$-in. wide, $\frac{5}{8}$-in. high. Weight of the switch without leads is less than 1 oz. The expanding element lies directly against the hot surface to be controlled, giving quick and positive response. Modifications of the basic design can be made to take care of numerous surface temperature control problems in various fields.

Anthony Mfg. Co., Inc.,
407-409 *Main St., East Orange, N. J.*



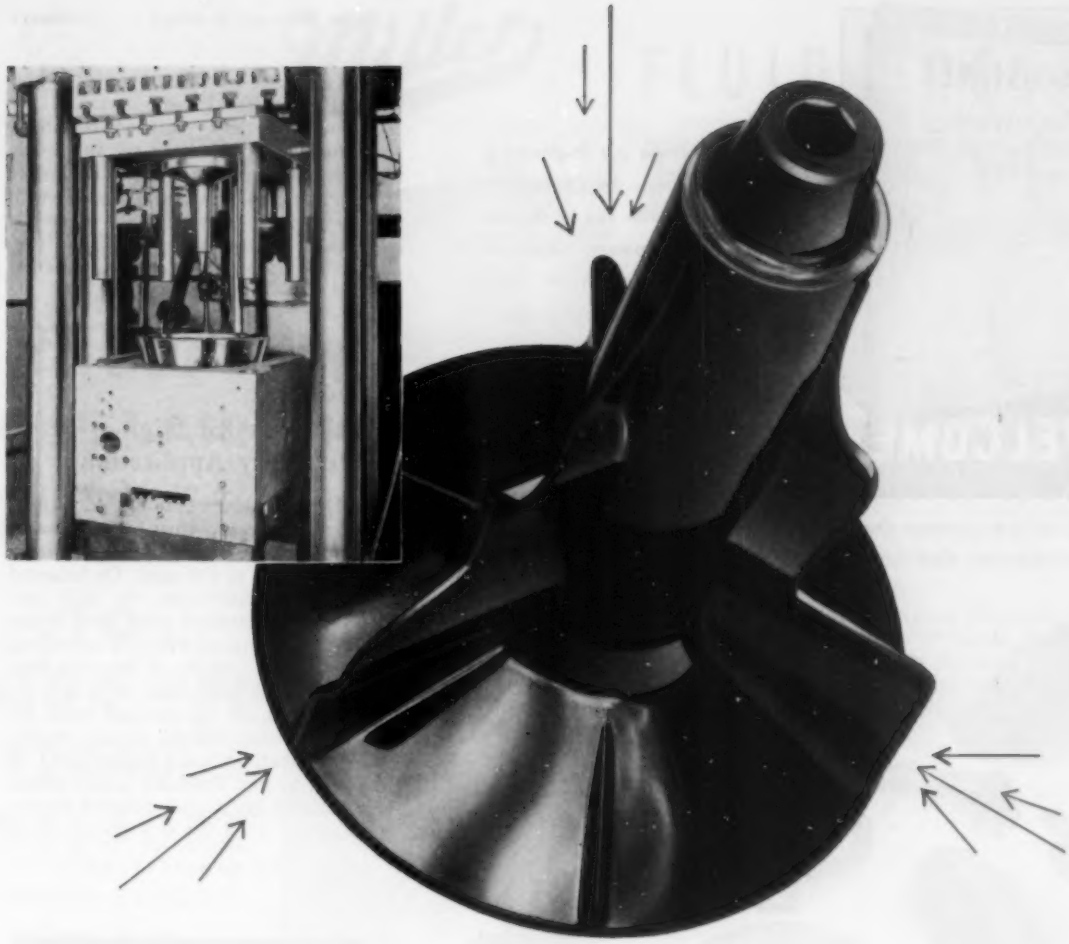
Electronic Data Reducer

For the precise performance analysis of such diversified products as tractors, aircraft, naval vessels, petroleum, guns and guided missiles, a new electronic data reduction machine permits the rapid semi-automatic reading of both oscillographic and film records.

This new electronic data-reducing device provides a valuable link between graphic information and modern high-speed digital computers. With this analyzer and reader, plus an accompanying digitizer, the user can quickly read and calibrate multichannel oscillographs or films recorded on either rectangular or curvilinear coordinates, supplying the data automatically to a computer and an electric typewriter simultaneously. Both arithmetic and algebraic corrections, either linear or non-linear, are applied graphically. For example, logarithms, sine functions or vector sums can be applied directly while reading traces.

The new data reducer also contains a projector and adjustable-speed mechanized movement for enlarging and analyzing continuous 16 mm and 35 mm microfilms.

Outputs from the new analyzer-reader are connected directly to any of three types of digital converters, which automatically punch paper tape or business machine cards or record



how PRP puts a new twist in *Phenolic moldings*

When Whirlpool Corporation laid down specifications for this unique Surgomatic agitator, some of the molding industry's oldest producers threw up their hands, said it couldn't be done. Exceptionally undulated vanes which provide a more efficient washing action required a "new twist" in plastic molding.

But PRP engineers went to work, added specially designed heavy-duty equipment to rapidly produce this type molding. A chrome-plated, 5¾ ton die that opens like a three-petaled flower and mounts on PRP's new, thousand-ton presses, turns out the Whirlpool agitator and similar parts in quantity.

Answers to problems that "can't be solved" and volume, on-schedule production of phenolic, urea, melamine or alkyd moldings are typical of PRP's flexible operation.

And it's yours to command. We've the heavy-duty equipment to furnish you custom moldings, large quantities or small, and deliver them right to your door in our own trucks. Write, wire or call for conscientious PRP service . . . or send for our plane, ready to fly you directly here for discussion of your particular plastic molding problem.

PRP

when you look for plastic moldings, look first to
P lastic R esearch P roducts
Urbana, Ohio

At all times our Engineering Staff welcomes the opportunity of working with you on the design, development, improvement or production of "precision" molded rubber parts.

Whether the required part is complex in design or must overcome problem conditions involving fluids, gases, friction, flexing, high or low temperatures, we are confident the specialized knowledge of our engineers can produce the right answer — the first time!

Long experience in precision techniques, plus alert, progressive thinking enables ACUSHNET to accept the challenge of any problem — any new application, requirement or development of molded rubber parts. Your inquiries will be given prompt study and recommendations.

Acushnet
PROCESS COMPANY

Send for your copy of the new "Acushnet Rubber Handbook"

Address all communications to 768 Belleville Ave., New Bedford, Mass.

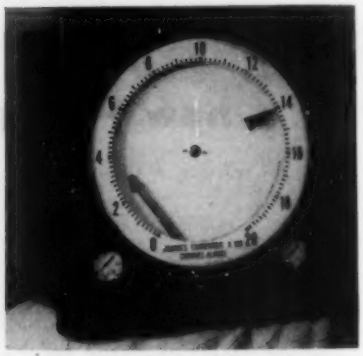
on magnetic tape for input to various kinds of digital computers. At the same time, this digitized output is automatically tabulated on an electric typewriter, if desired. Still another simultaneous operation is possible with the new unit connected to an automatic plotter, for replotting the data from oscillographs or films to different scales.

Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

Capacitor for High-Frequency Applications

High-frequency tuning capacitors for television and other high frequency apparatus are being produced in a range of 0.4 to 0.8 mmf. Of balanced dielectric construction, the unit consists of a metallized glass rotor fitting to close tolerance within a metallized glass stator. Made of precision-bore glass tubing, rotor and stator are directly soldered to standard brass fittings for conventional chassis mounting. Capacitor has a minimum Q of 500 at 50 mc. Tolerance is still within prescribed limits after 100,000 revolutions.

The Hermaseal Co., Elkhart, Ind.



Recording Controllers

A new line of process instruments including potentiometric and a-c bridge recorders and recording controllers are available with either electric or pneumatic control. They are equipped with a centerless pointer that simplifies chart changing and leaves practically all of the chart exposed to view for easy reading.

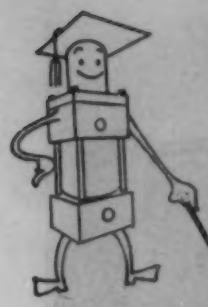
A new magnetic standard is said to eliminate dry cells, slidewires and many moving parts found in conventional potentiometric instruments.

Heart of the a-c bridge system, the

Miller

FLUID PRESSURE BOOSTERS

In "Custom-Built" and "Stock" Models!

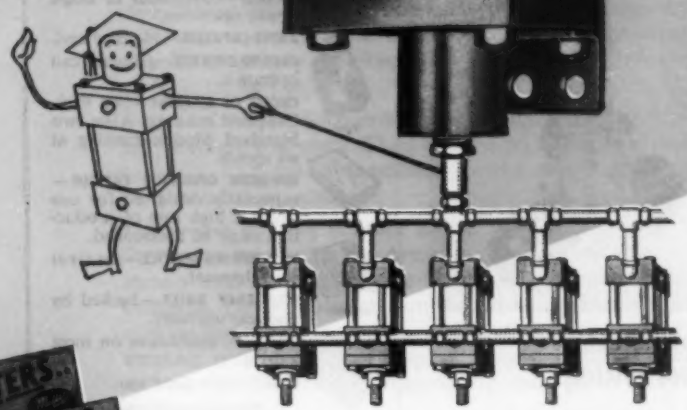


BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

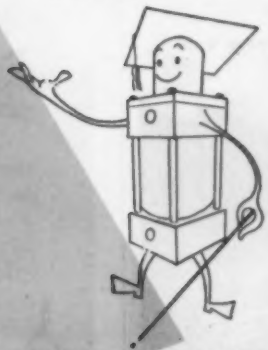
Output Range: 200 to 10,000 psi Fluid



Get immediate delivery on the popular 5" bore Miller B4 (Air-Miser) Dual Pressure Booster, Model 53, with a 1" dia. hydraulic ram and "stocked" in your choice of either 6" or 12" stroke. Booster ratio is 25 to 1 (80 psi air input provides 2000 psi hydraulic output for driving one or more work cylinders simultaneously).

Separate booster air-oil tanks of 5" bore, in both 6" and 10" heights as desired, are also available for immediate delivery together with foot mounting attachments for speedy conversion of Model 53 to Model 71.

These "Stock" Boosters are identical in quality to Miller "Custom-Built" boosters which are available on normal scheduled delivery in a wide selection of models, ratios and output capacities as described and illustrated in Bulletin B-200. Write for bulletin and prices.



ESPECIALLY RECOMMENDED FOR

- WELDING
- PUNCHING
- SHEARING
- CLAMPING
- RIVETING
- CRIMPING
- PRESSING

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST

Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

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Miller

MILLER FLUID POWER CO.

(Formerly MILLER MOTOR COMPANY)

2002-04 N. HAWTHORNE AVE. • MELROSE PARK, ILL.

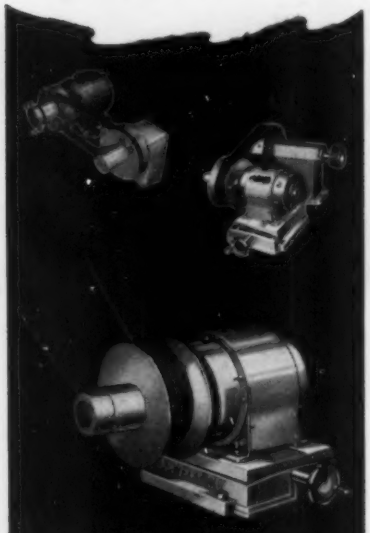
AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Announcing . . . the great

LEWELLEN VARIABLE PULLEY

with all its NEW features

- Uses 40% less space
- Has 50% less overhung load
- Costs less per H.P.
- Has fixed or adjustable centers for horizontal or vertical shafts
- Scaled to new N.E.M.A. motors
- Fits present motors
- Engineered for smooth, quiet, trouble-free power transmission
- Built to Lewellen quality standards
- Fractional to 15 H.P.
- Up to 4 to 1 speed range with single variable pulley
- Up to 10 to 1 speed range with combination pulleys



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TRANSMISSIONS • MOTOR PULLEYS

Service in variable-speed control exclusively for more than 50 years. May we help you?

LEWELLEN MANUFACTURING CO.
COLUMBUS, INDIANA

new bridge-balancing unit supplies power to the bridge and provides a means for rebalancing it. In cases where the variable under measurement is temperature, the circuit is unbalanced by changes in the resistance bulb. Balancing is achieved by a servo motor which repositions the balancing unit's rotor.

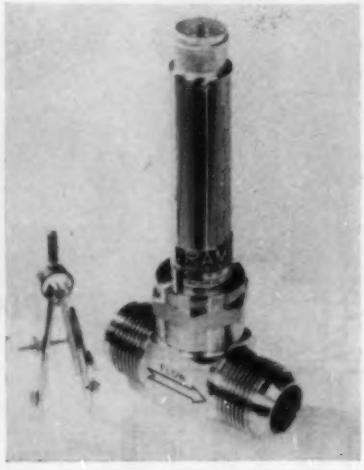
Other advantages of the equipment include plug-in components, anti-backlash gearing, internal illumination and an integral pen-inkwell assembly designed for automatic realignment.

The reinforced steel case and die-cast aluminum cover are sealed with "Neoprene" gasketing against dirt and moisture and can be furnished for either wall or flush mounting.

Chart speeds are 1, 4, 8, 12 and 24 hr, and 7 days.

Net weight of the products varies from 75 to 95 lb according to form of control and measuring system. The units utilize a 120-v, 60-cycle power supply. The potentiometer has a power consumption of 65 w; the a-c bridge, 40 w.

General Electric Co., Schenectady 5, N. Y.



Flow Transducer Eliminates Fittings

Through a new principal of sensing liquid velocity, a new flow transducer is said to provide simpler, lighter weight, more accurate and trouble-free fluid measurement. No leveling, screening, filtering or connection piping is required. The device can be installed in any position at any union.

The new transducer has no bearings, packings, stuffings, bushings, bellows diaphragms, glass tubes, pistons, vanes, contaminating fluids or mercury. In this design, fluid flow is

Want PRECISION SHEARING *at High Speed?*

Check These Features and You'll Want a

DI-ACRO* POWERSHEAR

METALS

RUBBER

MICA

FIBRE

PLASTIC

LEATHER

SCREEN MESH

PRECISION—strips less than .025" wide accurately sheared, thousands of parts exactly duplicated.

CUTTING SPEED—ranges from 30 to 200 S.P.M. on Vari-O-Speed models—continuous or single stroke operation.

RATED CAPACITY—16 gauge steel.

EASY TO OPERATE—a woman can operate it.

CHOICE OF MACHINE—two Vari-O-Speed models. Also two Standard Models running at set speeds.

MINIMUM OPERATOR FATIGUE—especially designed for use where a high rate of production must be maintained.

ENGINEEPING SERVICE—always at your disposal.

RUGGEDLY BUILT—backed by one year warranty.

DELIVERY—immediate on most models.

COST—that's good too.

*pronounced Die-ack-ro.

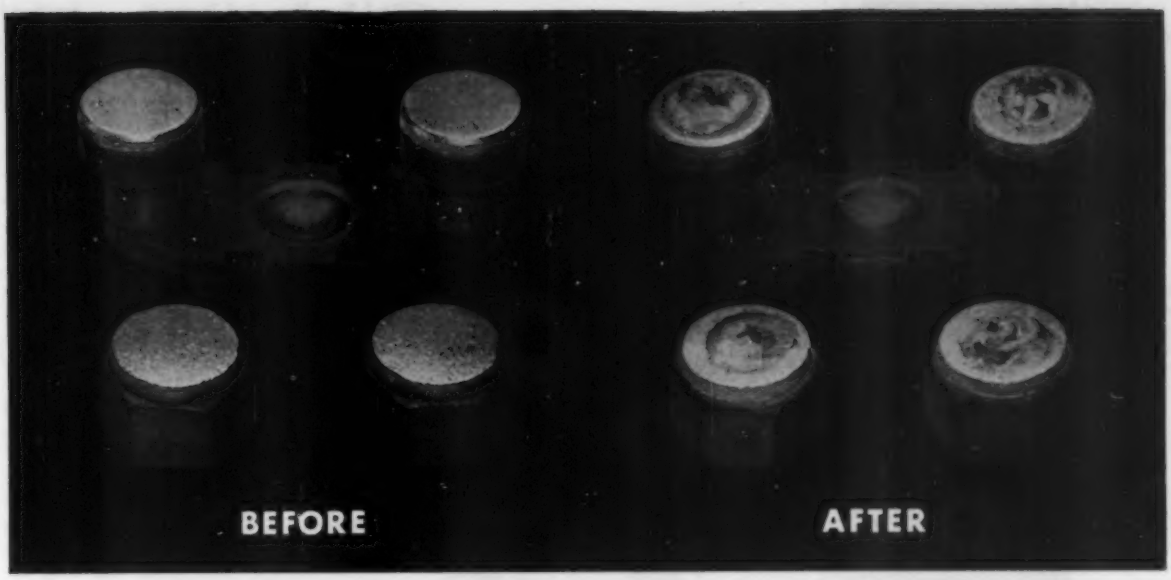
SEND FOR CATALOG

Gives full details on both hand and power operated Di-Acro Shears, Benders, Brakes, Rod Parters, Notchers, Rollers and Punch Presses.

Creators of "Die-Less Duplicating"!

O'NEIL-IRWIN MFG. CO.
333 Eighth Avenue
LAKE CITY, MINNESOTA

di-acro PRECISION METALWORKING MACHINES



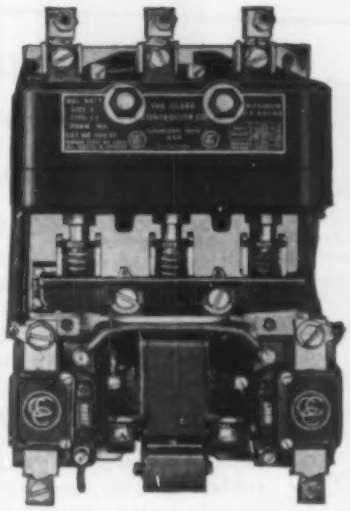
PROOF OF LOW MAINTENANCE ON CLARK TYPE "CY" STARTERS

These unretouched photos show contact tips from a CLARK Bulletin 7707 contactor—the contactor used in the standard Bulletin 6013 size 2 AC Motor Starter — as they looked before and after a year of hard use.

The contactor is in service at Cleveland Hone and Manufacturing Company, on a special transformer and rectifier circuit used in processing automotive parts. The tips shown right above were removed from the contactor after 12 months of steady service, often operating as frequently as 5000 times per hour.

Note that slight discoloration and minute pitting are the only evidence of wear. They require no cleaning, dressing or filing, and are in condition to give many more years of dependable service.

The secret of long contact life in the CLARK Type "CY" Starter is its exclusive arc-quenching principle, using strong multi-turn magnetic blowouts and double-break contacts. Forced rotation causes the arc to move continually on the contact surfaces, distributing the heat and preventing pitting or "build-up" at any one point. Result: extremely effective arc interruption, and greatly reduced wear on tips.



CLARK Type "CY" Starters include many more features for dependable service and reduced maintenance. Let us tell you the complete story.

Write for descriptive literature.

The CLARK CONTROLLER *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

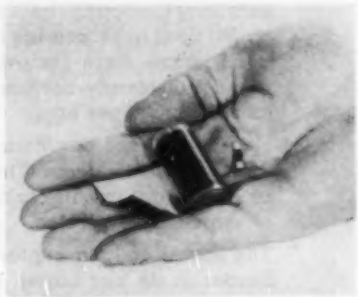
sensed as a product of the dynamic forces of fluid friction, acting upon a body immersed in the stream. The resultant drag force is registered by the strain-sensitive member supporting the revolving body. Bonded strain gages in a four active-arm bridge circuit translate this mechanical force into a proportionate electrical output.

Sensing and other critical elements are 18-8 stainless, heat-treated. Mechanical stops protect against pressure surges, entrained gases and solids. The electrical system is sealed.

Accuracy and readability is aided in the new transducer by expending the scale to include only the area of desired measurement. A ratio of about 5 to 1 is used. Translation is accurate within less than ½ percent. This high sensitivity makes this device suitable for use with high-speed recording devices, since the natural frequency on such units already in service range from 70 to 200 cps (depending on meter flow range).

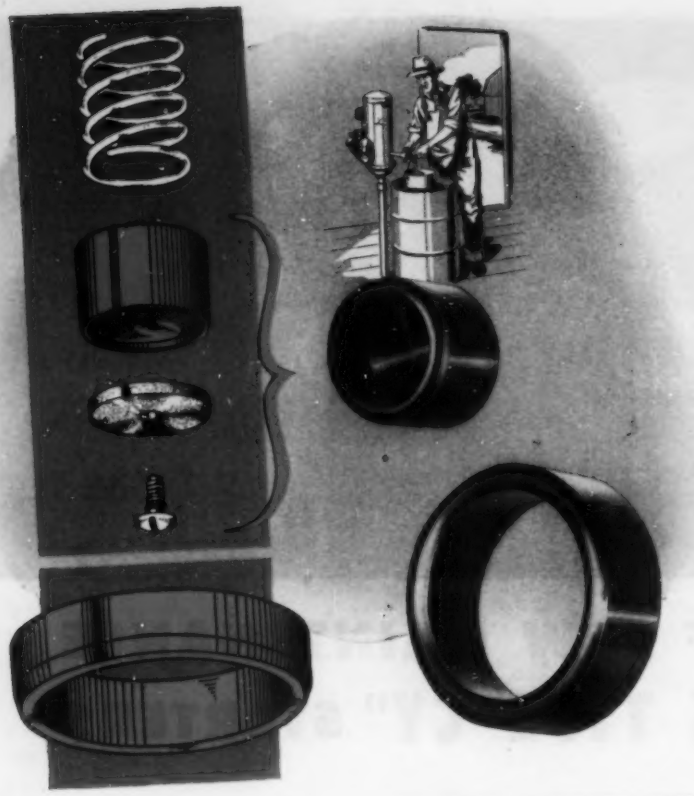
The 1-in. transducer model measures only 1½ x 3½ in., weighing 1.75 lb. A model with anodized aluminum housing and external parts is also available. Range of sizes is based on both pipe and tubing standards.

Ramapo Engineering Co., 1 Dey Lane, Riverdale, N. J.



Tape Resistors For Printed Circuits

Stable tape resistors for a wide range of printed circuit applications are available either as cured, ready-to-use resistors or as uncut, uncured tape rolls. They are ½-in. long, ⅛-in. wide and 1/100-in. thick. Both types have a resistance range of 100 ohms to 10 megohms. They can be used in circuitry where exacting requirements must be met. They conform to all JAN-R-11 specifications. These resistors are suitable for semi-automatic applications in which a single operation, said to require less than 1 sec, fastens them permanently to the chassis



How G&K-INTERNATIONAL helps The Lerio Corporation cut costs by replacing machined metal parts with *molded* synthetic rubber

In the Lerio Automatic Water Pump suction is formed by two pistons operating within a small galvanized steel tank.

Discharge valve body in each piston head was formerly of brass, machined to seat a spring and retain a washer held in position with a screw. Seat in the foot valve assembly was formed from brass tubing and required three turning operations.

G&K-INTERNATIONAL engineers developed a simple cup-shaped valve body and a seating ring molded of synthetic rubber. Results: much quieter operation, and real savings in manufacturing cost and assembly time.

G&K-INTERNATIONAL is ready to work with your engineers to develop molded synthetic rubber or impregnated leather parts which may offer savings to you.

Write for G&K-INTERNATIONAL Catalog and Manual 201-A. 60 pages of up-to-date data including latest JIC and officially recommended sizes for cups, flanges, U's, V's, O-Rings — also facts on oil seals and specialties.

G&K-INTERNATIONAL *Packings*

GRATON AND KNIGHT LEATHER — SYNTHETIC RUBBER

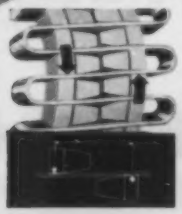
GRATON & KNIGHT COMPANY, Worcester, Massachusetts
INTERNATIONAL PACKINGS CORPORATION, Bristol, N. H.

P-4

• Any size • Any service
• Any application • Horizontal or vertical • Always available

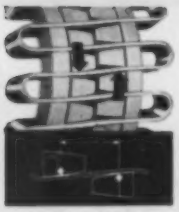
Exclusive FALK Steelflex grid-groove design smothers shock and vibration.

The damaging effects of shock and vibration can shorten the life of any connected machinery. Here is how the Steelflex grid-groove design overcomes these common enemies.



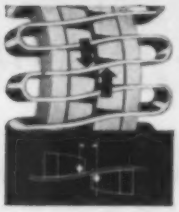
Under LIGHT LOADS

The gridmember bears only at outer edges of grooves. The long span between points of contact remains free to flex under load variations.



Under NORMAL LOADS

As load increases, the distance between supports on the grooves is shortened proportionately, but a free span remains to cushion shock loads.



Under SHOCK LOADS

Under extreme overloads, the grid-member bears fully on the grooves and transmits full load directly. The coupling remains flexible, within its rated capacity.

Why FALK Steelflex Couplings give the *finest* protection for connected machinery

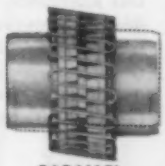
Maximum protection of connected machinery is best provided by Falk Steelflex Couplings because, thanks to their exclusive design, they overcome the damaging conditions of shock loads, shaft misalignment and vibration. How this unique multiple protection is made possible is shown at the right.

Falk Steelflex Couplings give the most economical protection, too, because they make connected machinery last longer and give better service. Furthermore, when actual coupling costs are figured per year of service, Falk Steelflex Couplings show substantial savings through their rugged all-steel construction, easy interchangeability and low maintenance requirements.

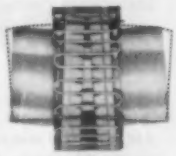
The basic Type F Steelflex Coupling—in 33 sizes to cover capacities from 2/5 through 70,000 hp per 100 rpm—meets over 90% of all industrial applications. Special or Dual Purpose Steelflex Couplings are available for problem applications. Write to Department 247 for engineering bulletin, including selection and dimension details.

...Accommodates shaft misalignment and free end float

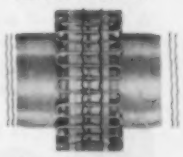
Basic maintenance procedure dictates regular inspection and correction of shaft alignment. Between inspections, Steelflex couplings provide protection by accommodating unavoidable shaft misalignment and end float. The gridmember which connects the two hubs of a Steelflex coupling is not fastened to either hub, so each hub can shift without imposing load on the other shaft.



PARALLEL MISALIGNMENT



ANGULAR MISALIGNMENT



FREE END FLOAT

THE FALK CORPORATION, Milwaukee 8, Wisconsin

MANUFACTURERS OF

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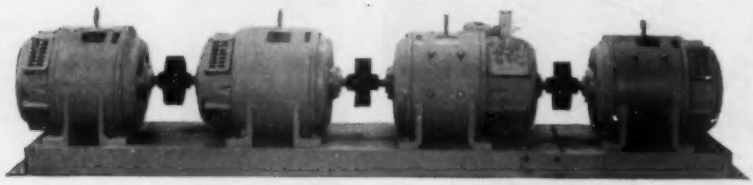
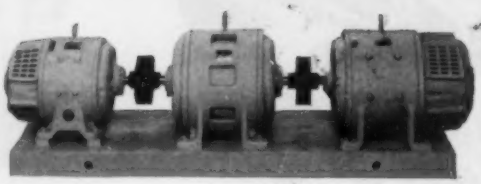
CALIDYNE'S *latest advance*

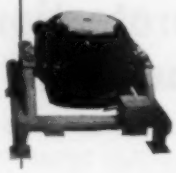
IN LARGE SHAKER SYSTEMS FOR PRODUCT VIBRATION-TESTING





the new m47 ROTARY POWER SUPPLY

FOR USE WITH THE MODEL 48A SHAKER



PROVIDES WIDE UNBROKEN FREQUENCY RANGE

One alternator, in place of three in earlier power supply designs, provides the 5 to 500 cps frequency range. This wide, unbroken range is especially useful in vibration-testing products and parts to MIL-E-5272 and similar requirements. A second dual alternator supplies a range of 500 to 2000 cps.

ELIMINATES POWER FACTOR CORRECTION

The new power supply has sufficient reserve, even under adverse loads, to permit maximum operating efficiency *without power factor correction*. Thus the important advantage of uninterrupted testing, through the ranges 5 to 500 cps, and from 500 to 2000 cps.

REDUCES OVERALL SHAKER SYSTEM COSTS

The elimination of power factor correction and previously required alternators, reduces the overall price of the basic 2000 cps Shaker System by approximately 10%. The new Calidyne System itself is composed of the Model M47 Rotary Power Supply, the new Model M119 Control Console and the Model 48A Shaker. A full line of accessories — signal monitor, frequency cycler, servo control and degaussing coil and controls — is available for this new system. For technical data and information on standard or special Calidyne Shaker Systems to meet your requirements, call on Calidyne today.

THE CALIDYNE COMPANY

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and connects them into the circuit, without soldering, bending of leads or punching holes in chassis.

Power rating is $\frac{1}{4}$ w at 150 C, Resistance tolerance: 10 percent, temperature range —55 C to 200 C, Humidity: 95 percent at 40 C for 250 hr, temperature coefficient: within requirements of JAN-R-11. Shelf life: 18 mo min., load life: 500 hr min, $\frac{1}{4}$ w at 150 C.

Sanders Associates, Inc., 137 Canal St., Nashua, N. H.

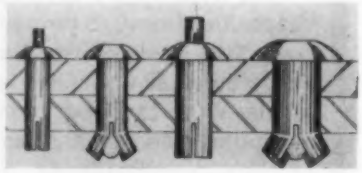
Catches Particles Worn Off Moving Parts

A lightweight permanent magnet separator, "Model PX-2," for hydraulic fluid systems removes very fine steel particles that wear off and are washed away from moving parts.

This separator was designed specifically for use in aircraft hydraulic circuits but may be installed wherever working pressures do not exceed 3000 psi. The fluid enters from either end and is filtered through a stack of soft steel grids which are strongly magnetized by permanent magnets.

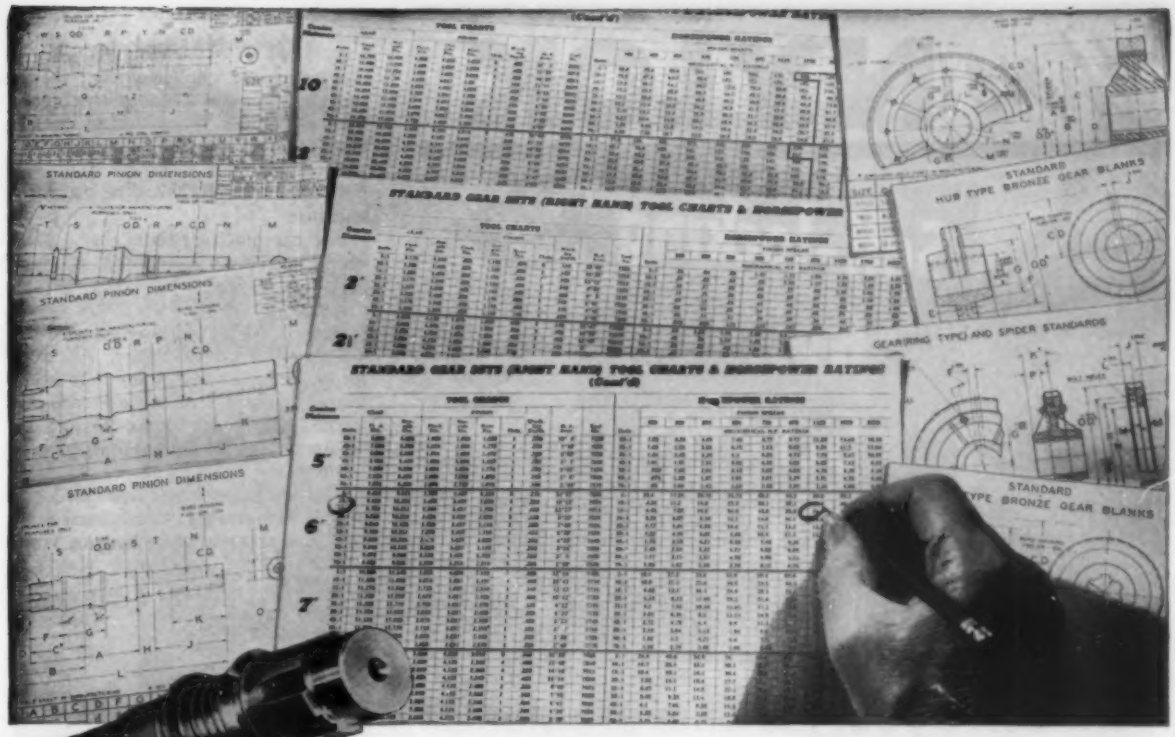
The separator is $5\frac{2}{8}$-in. long and $2\frac{7}{16}$-in. dia. Made for $\frac{1}{2}$ in. tube connections, it has a maximum capacity of 10 gpm. Hydraulic "O"-ring gaskets provide a positive seal at both ends. Its dry weight is 3 lb.

S. G. Frantz Co., Inc., Trenton, N. J.



Hammer Blow Installs Blind Rivet

Installed from one side of the job by one man working without special tools, a new $\frac{5}{32}$-in. dia blind rivet is applied with only a hammer. The rivet


STANDARD PINION DIMENSIONS
STANDARD PINION DIMENSIONS
STANDARD PINION DIMENSIONS
STANDARD GEAR SETS (RIGHT HAND) TOOL CHARTS & HORSEPOWER
STANDARD GEAR SETS (RIGHT HAND) TOOL CHARTS & HORSEPOWER RATINGS (Cont'd)
STANDARD HUB TYPE BRONZE GEAR BLANKS
GEAR (RING TYPE) AND SPIDER STANDARDS
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Specify STANDARD Cone-Drive Gears and get all these advantages

***plus* this vital feature**

Standard *Cone-Drive gears and worms are carried in stock. Cone-Drive gears are noted for their long life—BUT if a failure should occur at any time, replacement gears and worms are available without delay.*

Ask for Catalog No. 700

Lower Cost—due to smaller size of gears and housings, mass production of worm and gear blanks, etc.

Compactness—due to distribution of load over greater contact area, reducing unit pressures. As a result, gear sets can have smaller center distances, enclosures can be smaller, etc.

Less Weight—due to smaller center distances for a given horsepower or torque. Other types of gearing weigh up to 3 times as much for the same horsepower transmitted.

Greater Smoothness—because Cone-Drive gears have more teeth in continuous contact than other forms of gearing.

Wide Range of Sizes—Center distances from 2″ to 18″ provide horsepower ratings from fractional up to 800 horsepower. Ratios range from 5/1 to 70/1.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
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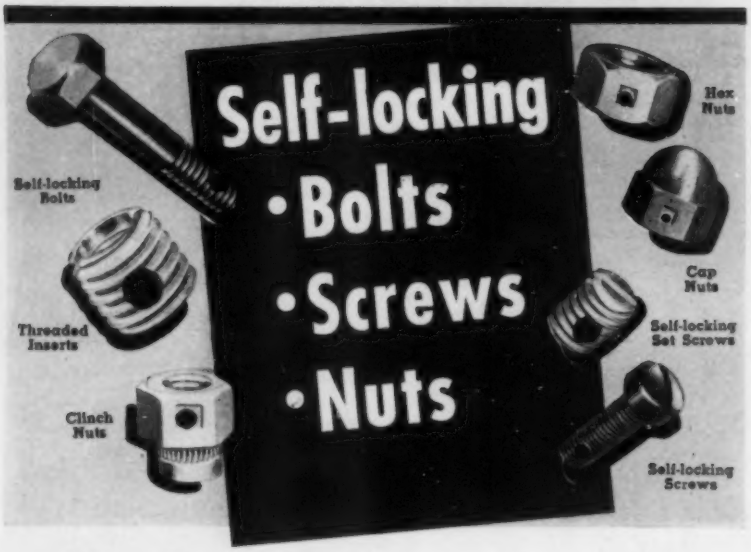


will solve your fastener problems at *Lower Costs!*

NYLOK one-piece self-locking fasteners cut manufacturing and maintenance costs, give a better fastening, and improve product appearance. That's because NYLOK fasteners eliminate costly safety wiring, lock washers, jam nuts and other "extras".

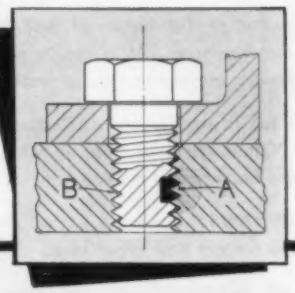
The NYLOK principle* locks threads securely in any position, seated or unseated. The resilient nylon plug provides a smooth wedging action which is vibration-proof and will not mar mating surfaces. It provides a leak-proof seal where liquids are present.

ONE-PIECE NYLOK CONSTRUCTION eliminates expensive extra locking parts, is always there so can't be left out or forgotten. This construction also means that NYLOK fasteners give you faster, easier assembly time. NYLOK fasteners can be re-used many times.

• Let NYLOK engineers help you solve your fastening problems. Write, stating your needs and NYLOK engineers will make recommendations at no obligation.

• *HOW NYLOK LOCKS •
Resilient nylon pellet (A) sets up lateral thrust, smoothly wedging mating threads together (B). All of locking action is on the threads; head is not stressed. Locking is positive, seated or unseated. Provides leak-proof seal where liquids are involved.

For full specifications and details of service approval . . .



• HOW NYLOK SEALS
When the fastener is seated, one flank of the mating threads is in bearing. Therefor, liquids can only follow the helical path of the threads, and this helical flow is effectively dammed by the nylon pellet.

Write, Wire or phone today!

NYLOK Corporation

Manufacturers of Nylon-Locked fasteners covered by U.S. patents and patents pending

Main Offices and Factory — Elmira Heights, N. Y.

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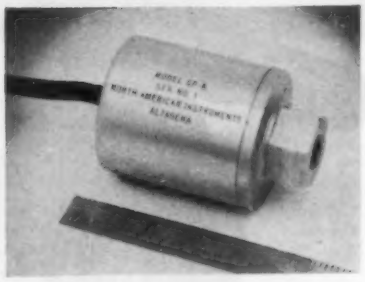
is inserted into a hole and the pin protruding from the rivet head is struck with a hammer. Four prongs on the blind end of the rivet are thus expanded, forming a second head and pulling panels tightly and permanently together.

The manufacturer states that no finishing operations are needed: no buffing or grinding, no stem to be trimmed.

Because pulling, exploding or twisting actions are unnecessary, all costly special expanding tools are eliminated. Thus, the number of workers who can install these rivets is not limited by the number of specialized tools present in the plant.

The new fastening is now produced in four diameters, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, and $\frac{1}{4}$ in. and in a range of grip lengths, from $\frac{1}{32}$ to $\frac{5}{8}$ in.

Southco Div., South Chester Corp., Lester, Pa.



High Range Pressure Transducer

This pressure transducer is suitable for both static and dynamic measurements. The dynamic response is stated to be more than sufficient for most measurements involving transient pressure phenomena. The natural frequency runs from 2000 cps at the lowest range to 10,000 cps at the highest.

The "Model GP-8" has been designed with particular emphasis on resistance to mechanical vibration and shock excitation. The acceleration response in the excitation most sensitive axis is less than 1 percent full scale per 1000 g in all ranges above 1000 psi. Important applications are indicated in rocket and jet engine testing where the close mechanical coupling required for high frequency response introduces mechanical excitation. Other applications include laboratory measment and industrial control using indicating, recording and control systems adapted to operation with variable reluctance type transducers.

The construction of the new trans-

LOGAN . . . a national participant in major fluid power advancements

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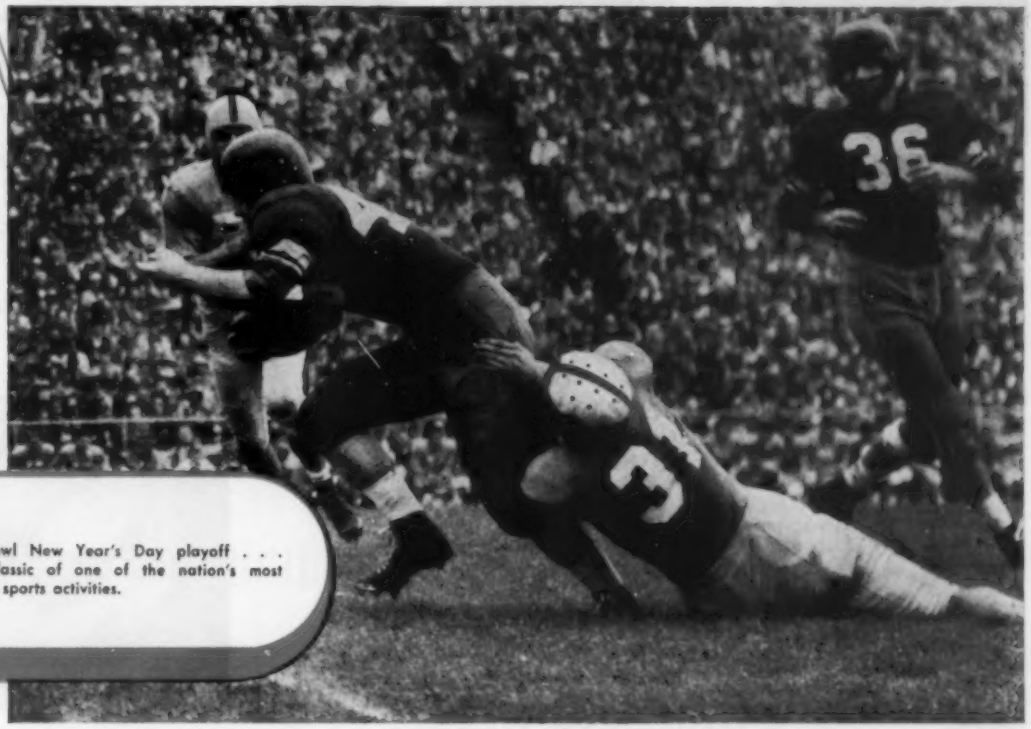

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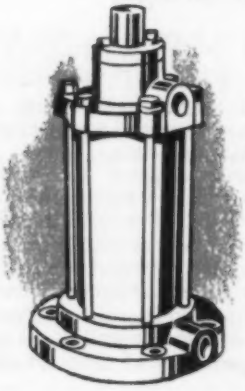
LOGAN HYDRAULIC CYLINDERS



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NONROTATING TYPE
7 STANDARD MOUNTINGS

Eight standard sizes from 2" to 8" diameter bore. Maximum operating pressure 750 p.s.i.

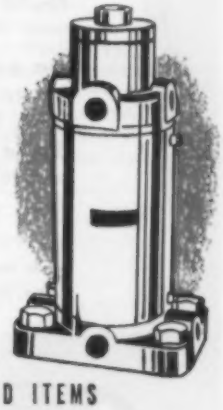
ROTATING "HR" TYPE

Seven standard sizes from 3" to 14" diameter bore. Maximum operating pressure 500 p.s.i.

ROTOCAST® SERIES
7 STANDARD MOUNTINGS

Sizes from 2" to 8" bore; any length stroke up to 8 feet as standard. Four piston rod end types. Operating pressures to 1500 p.s.i.

Consult Logan for your special heavy-duty, mill-type cylinder requirements



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SAVES TIME — Logan — AIR AND HYDRAULIC EQUIPMENT — EFFORT • MOTION

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a special message for manufacturers of military equipment

need a finish to beat these specs?

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if you're finishing under these or similar specifications, here's how you can use Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER... Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

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WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

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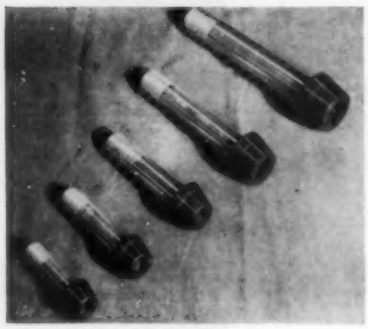
ducer incorporates a pressure sensing diaphragm with the steel body. The natural frequency is determined only by the diaphragm; there are no additional elements to lower the natural frequency or to produce spurious modes of vibration. The electrical pick-off elements are potted with epoxy resin in plugs which are screwed into the body. All metal surfaces are finished with electrolized chrome for resistance to corrosion and wear. The weight is 12 ounces.

Any excitation frequency from 60-50,000 cps may be used, the maximum input voltage at 3000 cps being 20 v. The full scale output is 50 millivolts per volt input in bridge circuit operation. The rated accuracy including linearity is 1 percent full scale or better.

North American Instruments, Inc., 2420 N. Lake Ave., Altadena, Calif.



Production Bolt Has 200,000-225,000 Psi Tensile Strength

Precision bolts with a rated tensile strength of 200,000-225,000 psi are now being produced. These bolts are reported to be the strongest steel fasteners of their kind ever to be made on a production basis.

Primarily designed for airframe assemblies, the new high-tensile fastenings are expected to make it possible to use fewer bolts or smaller size bolts.

Key to the production of a 200,000-225,000 psi aircraft bolt has been the maker's ability to cold-roll finished threads into exceptionally hard steel. This required special tools and equipment.

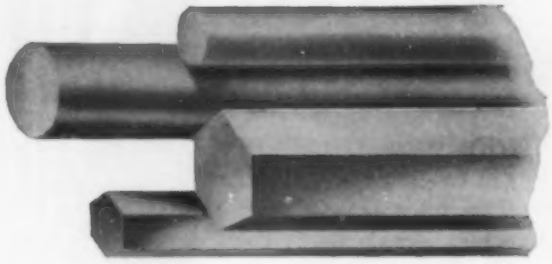
A bolt with a tensile strength of 200,000-225,000 psi. must have a hardness throughout of about 40-43 as measured on the Rockwell "C" scale. But to achieve full thread strength, it is necessary to roll the threads after, not before, the bolt has been heat-treated to this high hard-

55% in costs saved

on this screw machine part

by changing from brass

to Kaiser Aluminum



Mr. Ken Lemke, Lakeview Screw Machine Company, Ontarioville, Ill., reports:

"We have passed on to our customers a saving of approximately 55% per thousand pieces on this knob since we changed from brass to Kaiser Aluminum stock.

"One reason for this saving is the greatly reduced machine time permitted by aluminum. The brass knob required 12 seconds to produce, and the aluminum knob only 10 seconds. At that rate, it doesn't take long to build up a lot of extra machine time which we use to handle new business.

"Another saving was made possible because aluminum machines to a much better finish than brass. As a result, we simply anodize the aluminum, rather than chrome plating, as we had to do with brass. *And our tool life is much longer with aluminum.*"

Kaiser Aluminum screw machine stock is free machining; provides big material cost savings over other non-ferrous metals; can assure better parts because of its unique combination of properties.

Important suggestion for product designers! Be sure to request an alternate bid in aluminum with each bid you request in another material. This is the easy and logical way to compare both price and suitability of the materials. You'll find that aluminum usually will greatly reduce your per-piece cost and can give you a better part at the same time.

Call in a Kaiser Aluminum engineer. He'll gladly give experienced assistance with alloy selection, design considerations, production techniques. Prompt deliveries of round and hexagonal aluminum screw machine stock now being made by us and our distributors. Look for our local number in the classified telephone directory under the heading "Aluminum." Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service

flower of the
Engineered
Plastics
TEFLON and KEL-F
Electrically—The finest insulating materials known for VHF, UHF and microwave circuits operating in wide range of ambient temperatures and pressure altitudes to 80,000 feet.
Chemically—The only materials that are inert to all chemicals except molten alkali metals, fluorine under pressure and chlorine trifluoride.
Physically—The most anti-hesive material known, as well as tough, resilient, wear resistant.
But to gain all their outstanding advantages, these materials must be handled "just right" in their fabrication.
The United States Gasket Company offers "Knowhow", based on long experience—specialized facilities—and close Quality Control "from powder to part" to assure you TEFLON and KEL-F at their best.
Stock includes sheets, rods, tubing, tape, bars, cylinders, beading, and extruded shapes (the most complete line in the country).
Precision molded and machined parts are produced to customers' specifications.
Ask for Bulletins No. 300 and No. 500.
UNITED STATES GASKET COMPANY
CAMDEN 1 • NEW JERSEY
FABRICATORS OF duPont TEFLON, Kellogg KEL-F AND OTHER PLASTICS
Representatives in Principal Cities Throughout the World

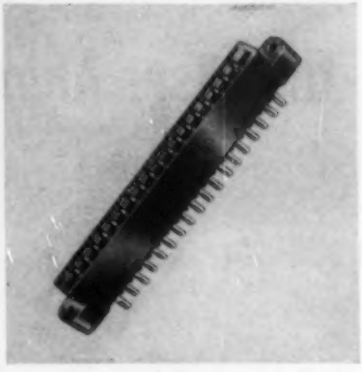
ness. Till now, satisfactory threads could be cold-rolled in steel with Rockwell hardnesses of only 38 or less—thus limiting the maximum strength of the bolt to about 160,000-180,000 psi.

The new aircraft bolts come in 12 sizes ranging from $\frac{1}{4}$ to $1\frac{1}{2}$ in. dia. They are forged from 8740, 4340 and 4140 high-alloy steels. Bolts up to $1\frac{1}{4}$ in. are cold forged; larger sizes are hot upset forged.

The finished bolt is produced free of decarburization and is cadmium-plated with subsequent hydrogen embrittlement relief. In material and test performance, they conform to NAS and MS military specifications.

To catch any imperfections that might destroy the carefully developed strength of the new bolts, rigid quality control is imposed on both raw material and finished product. All bar stock undergoes special steel analysis to detect seams or other metallurgical flaws prior to forging. All finished bolts are magnetic particle inspected.

Standard Pressed Steel Co., Jenkintown, Pa.



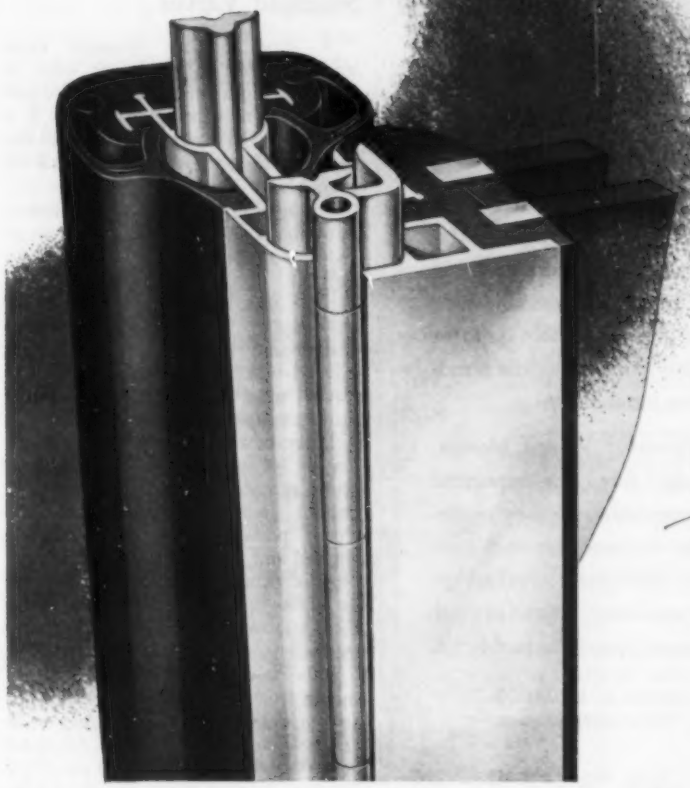
Printed Circuit Connectors

A new connector design for "plug-in" printed circuit card applications is available in sizes ranging from 6 to 22 contact positions. The contacts are spring temper phosphor bronze, to assure positive wiping action. They are offered in either of two terminal styles: a slotted eyelet for soldering up to three No. 20 AWG cable wires per contact or a plain terminal to permit wrapping the cable wire by using the tool specially developed for this work. Gold plating over silver provides low electrical resistance, prevention of corrosion and soldering ease. Contact millivolt drop is 10.5 d-c at 3 amp rated current.

One or more polarizing pins can be used to assure engagement in the

Harvey Aluminum will reduce your costs

HERE'S HOW *one manufacturer* **SAVED 77 ASSEMBLY OPERATIONS ON THIS REFRIGERATOR DOOR**



Cross section, showing redesigned refrigerator door frame made of interlocking Harvey aluminum extrusions and rubber insulation. Previous design required 85 hand-set screws. New design requires 8.

Working with Harvey's engineers a leading glass refrigerator door manufacturer* redesigned his door to take full advantage of the fabrication flexibility and the multiple function characteristics of Harvey aluminum extrusions. 77 hand assembly operations were eliminated and labor was reduced 4.8 man-hours per unit. Harvey's integrated team of research specialists, engineers and metallurgists can help you cut your costs in many ways. One example is the new Harvey 66S alloy. Write for bulletin today.

**Name on request*

The men at Harvey Aluminum are dedicated to the idea of improving your product while reducing your costs. And remember, we prepay the freight to your plant.

MAKING THE MOST OF ALUMINUM...FOR EVERYONE

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC.
TORRANCE-LOS ANGELES, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

An independent producer of aluminum extrusions in all alloys and all sizes; special extrusions, pressure forgings, bar stock, forging stock, tubes, impact extrusions, aluminum screw machine products and related products.

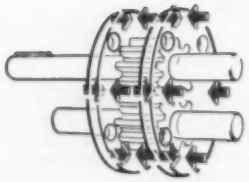
Back of the JOHN DEERE No. 55 Combine is a story of . . .

Oil Power

HYDRECO
Oil Power

The famous HYDRECO Four-Bolt design Hydraulic Pump provides Oil Power on the John Deere No. 55 Self-Propelled Combine to position the Auger Platform and control the Variable Speed Drive. This model 1506 Pump delivers 3.3 gpm at 1200 rpm with pressures to 1500 psi . . . other models to 130 gpm.

Build the hydraulic circuit around the dependability of HYDRECO components. More and more design engineers find this premise leads to successful performance in service whether the application be farm equipment, machine tools, materials handling or construction machinery.



Pressure Balanced wear plates maintain a fixed clearance between wear plates and gear faces regardless of pressure. This feature in HYDRECO Pumps and Motors minimizes oil slippage and power loss . . . volumetric efficiency and mechanical efficiency remain high!

HYDRECO Oil Power . . . Pumps, Motors, Valves and Cylinders have one important characteristic in common . . . they're *dependable*. And the engineering that contributes this dependability may be relied upon to make significant contributions to your present and projected hydraulic problems.

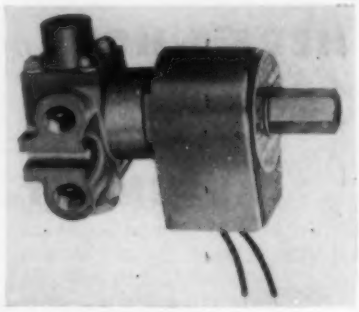
Write for brochures on HYDRECO Pumps, Motors, Valves and Cylinders.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1112 EAST 222nd STREET • CLEVELAND 17 • OHIO

correct position only. Mineral-filled melamine insulator bodies provide high dielectric strength, arc resistance and strong molded parts. All connectors may be panel or chassis mounted with machine screws.

Voltage breakdown between contacts at sea level is 3800 v d-c; at 60,000 ft altitude, 1200 v d-c.

Winchester Electronics, Inc., Dept. K, Glenbrook, Conn.



Midget Four-Way Solenoid Valves

A very compact solenoid valve standing only $4\frac{7}{16}$-in. high with an over-all length under 3 in. and depth of 2 in. is now being marketed. It is believed by the manufacturer that this is one of the smallest units of its kind available.

Permissible pressures range from a minimum of 10 lb to a maximum of 125 lb for ac and up to 50 lb for dc. Pipe size is $\frac{1}{4}$ in.; orifice diameters are $\frac{1}{16}$ in. inlet, $\frac{3}{32}$ in. exhaust. Power consumption is 10 w. The valve is designed for handling air, water, light oil and other non-corrosive gases and liquids at service temperatures ranging up to as high as 212 F.

These new valves are designed primarily for controlling small double-acting cylinders. They are also used to control two single-acting cylinders where pressure must be alternately applied and exhausted. Such combinations of pilot valves and cylinders are used for operating large valves and dampers, and on many types of automatically controlled equipment.

Valve bodies are of forged brass insuring freedom from porosity. Valves are packless with integral crown seats and resilient and nylon discs. All metal parts in contact with the fluid are either brass or stainless steel. Standard voltages are 115 or 230 a-c, 60 cycles, 115 v d-c. Other voltages and frequencies can be obtained.

Automatic Switch Co., Orange, N. J.

Catalogs and Bulletins

Request additional information using postcards following page 260

(1) STEAM TRAPS—V. O. Anderson Co., 1935 W. 96 St., Cleveland 2, Ohio. Catalog, 36 pp, describes new combination float and thermostatic traps, which vent air in one-eighth the time of standard inverted bucket traps. In addition, the catalog contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps.

(2) COPPER-CLAD PLASTIC SHEET—Formica Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio. Folder, 4 pp, describes epoxy-type, copper-clad laminated plastic sheet for use in printed circuits. Properties and characteristics are included.

(3) INDUSTRIAL HOSE AND FITTINGS—Anchor Coupling Co., Inc., E. Church and 4 St., Libertyville, Ill. Catalog, 103 pp, indexed with engineering information for proper estimating, installation, testing procedures. Individual sections describe one, two and three-wire hose, fabric-reinforced hose, couplings, adapters, unions, check valves and other fittings. Available sizes and styles, together with bursting strengths and other properties, are included.

(4) HERRINGBONE SPEED REDUCERS—W. A. Jones Foundry and Machine Co., 401 Roosevelt Rd., Chicago 24, Ill. Catalog, 160 pp, has quick selection tables based on desired ratios as well as other application data and even several helpful examples of good specifying practice. Tables and

A High Pressure Pump at a Low Pressure Price!

- **COMPLETE HYDRAULIC BALANCE . . . the exclusive DUAL-VANE Design provides and assures complete balance of all hydraulic pressure loads. You get continuous, maintenance-free operation with increased efficiency at all pressures.**
- **INCREASED OUTPUT . . . machine efficiencies can be increased by 2000 psi pump operation without change of other standard components in the hydraulic system.**
- **CARTRIDGE CONSTRUCTION . . . all pumping parts that move are contained within an easy-to-install cartridge. Pump output can be altered by changing cartridge; servicing is simplified and machine down-time reduced.**
- **ECONOMY . . . the low initial cost and the 2000 psi premium performance of DUDCO PF-100 Pumps can double the value of your *hydraulic dollar.***

Write for DUDCO Bulletin No. DP-302. You'll get the facts on the new PF-100 Series Pumps.

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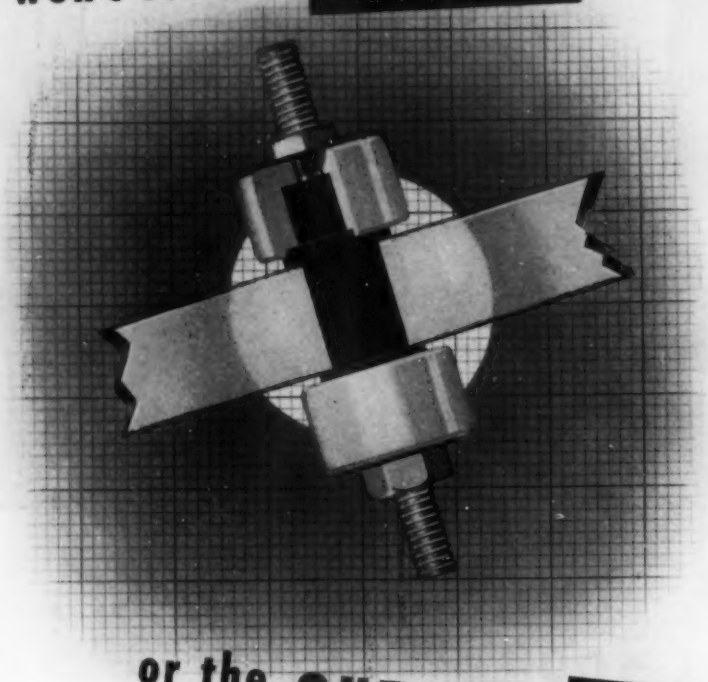
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.

LUNDEY hermetic terminals

won't let the **INSIDE** OUT!



or the OUTSIDE **IN** !

Do you have an electrical problem where low-cost *reliable* hermetic sealing is a must, to . . .

- contain highly diffusive gases or liquids, including the freons . . .
- maintain desired pressures . . .
- retain electrical efficiency under adverse environmental conditions?

The Lundey line of hermetic terminals is the answer to the design engineers' increasing demand for *reliable* terminals for hermetic sealing.

With over ten years of successful performance for highly critical military as well as industrial applications, Lundey designs have met unusual specifications, including such requirements as . . .

- excellent resistance to thermal and mechanical shock.
- high current and voltage.
- wide ranges of temperature and pressure.
- ease and simplicity of installation.

Why not let Lundey Associates help you solve *your* next hermetic sealing problem?

Lundey terminal 4780-25W. Designed for heavy-wall sealed [illegible] compressor units. Current capacity 100 amperes, continuous. Voltage rating, 5000 volts, test.

LUNDEY ASSOCIATES

694 MAIN STREET
WALTHAM 54
MASSACHUSETTS

drawings provide information on ratings and divisions of various types of reducers. Inquiry and order form, installation pictures also included.

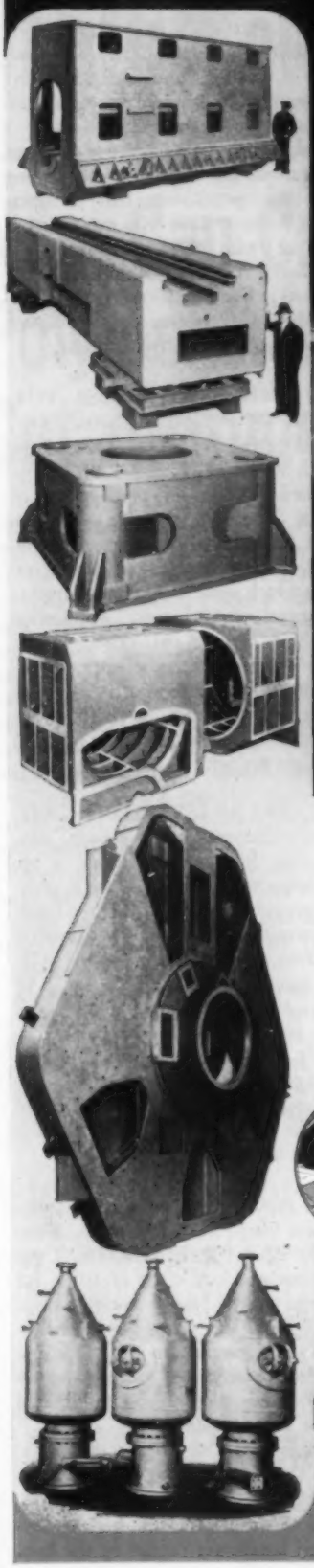
(5) SPRINGS — Newcomb Spring Corp., 3902-7 Ave., Brooklyn 32, N. Y. Bulletin NS400, 8 pp, describes compression, extension, torsion, power and flat springs. Illustrations include drawings of various types of springs and available spring end.s Curves on allowable working stresses also included.

(6) FLOATLESS LIQUID LEVEL CONTROLS—B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich. Catalog, 36 pp. Describes operating principle of relay, panels, electrodes and starters used for liquid level, pumping and industrial process controls. Details and characteristics of equipment included given in photographs, tables, drawings.

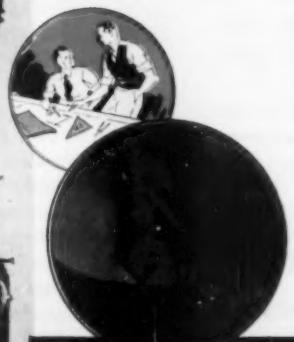
(7) FLEXIBLE SHAFTS AND COUPLINGS — Kupfrian Mfg. Co., 137 Prospect Ave., Binghamton, N. Y. Catalog 5494, 16 pp, contains information relating to the design and use of flexible shafts and couplings, broken down according to topic headings. Included is a table of the physical properties of 24 different flexible shafts ranging in size from $\frac{1}{8}$ to $\frac{3}{8}$ in. A similar table lists 29 different flexible shaft casings. Illustrated also in full scale are over 30 standard flexible shaft couplings and assemblies and over 100 components, including terminal fittings, casing ferrules, and nuts.

(8) TITANIUM TUBING—Superior Tube Co., 1556 Germantown Ave., Norristown, Pa. Bulletin 42, 8 pp. Properties, applications and advantages of titanium tubing are presented. Some of the research and development which went into the product is outlined, together with the properties of titanium which make it a promising material for many new applications. Tube sizes of seamless and welded titanium tubing are listed. Tubing tolerances, chemical analysis and finishes are other topics discussed and there is a section on processing and fabricating characteristics of this new tubing.

(9) ADHESIVES, COATINGS, SEALERS — Minnesota Mining and Mfg. Co., 423 Piquette Ave., Detroit



Use WELDED STEEL for Greater Strength with Less Weight!



The Crawler Side Frames illustrated above, parts of a large strip mining machine which were formerly produced in casting form, were redesigned and produced by Mahon as weldments. These and the parts and assemblies shown at the left are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for hundreds of manufacturers of processing machinery, machine tools and other types of heavy mechanical equipment. If you require welded steel parts, assemblies, or special purpose equipment, you can turn to Mahon with complete confidence . . . highly skilled personnel are available within the Mahon organization to do the complete job from drawing board to finished machining and assembly—thoroughly experienced personnel who are backed by tools and plant facilities with capacity to produce virtually anything in welded steel construction regardless of size or weight. You will find in the Mahon organization a unique source for Steel-Weld Fabrication . . . a source where skillful designing, advanced fabricating techniques and superior craftsmanship assures you a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Mahon's Insert in Sweet's Product Design File, or have a Mahon engineer call and give you complete information.

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DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

Baldor
ADJUSTABLE SPEED
MOTOR SYSTEM
SPEED CONTROL
DELIVERS SPEEDS
from 0 to 2400 r.p.m.
in 16 steps of 150 r.p.m.
each forward or reverse
POWER UNIT
The BALDOR Simplified Adjustable Speed motor system operates from A.C. circuits; delivers speeds from 0 to 2400 rpm., with instant, smooth acceleration to each higher speed; instant, smooth dynamic braking to lower speeds or stop. Reverses instantly—even from full forward to full reverse. Separate components—mount in any position or distance apart. SIZES: to 3 h.p. for 2 or 3 phase operation; to 1½ h.p. for single phase operation.
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The new BALDOR Baltric motors—smaller NEMA frames • more horsepower • less weight • streamcooled • totally enclosed • high performance • cool operation • simple design • compact contour rugged construction • protected ball-bearings • polyphase and single phase • integral and fractional ratings.
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2, Mich. Booklet, 12 pp, lists adhesives, coatings and sealers meeting government and armed forces specification requirements. In addition, a specification cross reference table shows the current specification number along with the specification that it supersedes, to assist those who may be more familiar with the old specification numbers. A short description of the end use is listed with each specification and, in many instances, a choice of this company's products is given.

(10) GENERAL PURPOSE TURBINES—Westinghouse Electric Corp., 401 Liberty Ave., Box 2278, Pittsburgh 30, Pa. Booklet B-3896, 20 pp, reissued. Covers the complete line of "Type E" turbines in ratings through 1500 hp. Describes design and construction characteristics as well as accessories which make these units adaptable to special requirements. Application of these turbines to drive pumps, fans, compressors, generators, papermaking machines, Jordans, beaters, coal pulverizers and line shafts is discussed. Specification and selection data are provided.

(11) STAINLESS STEEL CASTINGS — Empire Steel Castings, Inc., Box 139, Reading, Pa. Chart, 4 pp, designates specifications, analysis, physical properties and uses of a number of corrosion-resistant and heat-resistant stainless steels. It correlates the AISI type number and ASTM and SAE designations with this foundry's and ACI designations, so that users can readily identify the properties of their castings. In addition, principal alloying elements are given and helpful remarks regarding behavior of each steel in use are included.

(12) PLASTIC PACKING — Durametallic Corp., 2104 Factory St., Kalamazoo, Mich. Bulletin 461PE, 2 pp, describes packings made of teflon for sealing under difficult conditions in the chemical and petro-chemical fields. They are resistant to heat (recommended temperature range —90 to 450 F) and inert to most fluids used in the industries involved.

(13) MULTIPLE V-BELTS—Goodyear Tire & Rubber Co., Akron 16, Ohio. Brochure includes recently approved horepower ratings by the Rub-

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

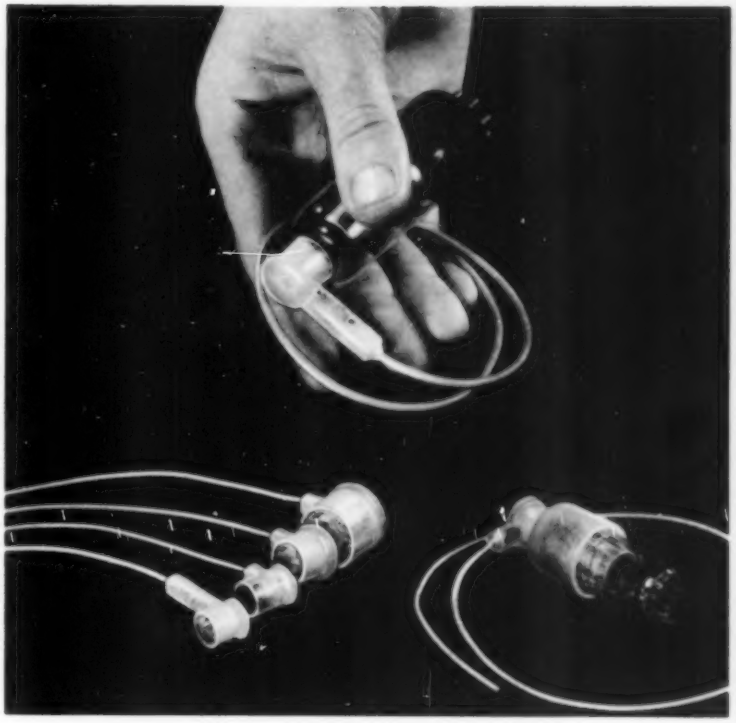
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company JUNE-JULY, 1954

New Cap Connectors of KEL-F® Polymer Widen Tube Service Range... Cut Altitude, Moisture "Arc-Over"!

Exceptional moldability of KEL-F and special equipment permit the "insert" molding of grid cap leads and resistors into a one piece insulated jacket. Conventional wire holes are eliminated, preventing insulation "pull back". Zero moisture absorption of KEL-F polymer and the elimination of wire holes precludes moisture collection which formerly caused "arc over" under high humidity.

The high insulation resistance and dimensional stability of KEL-F polymer over a wide temperature range (minus 320°F to plus 390°F) permits use of these connectors in critical installations subjected to extremes of temperature.

Alden Products Company, Brockton, Mass., uses KEL-F trifluorochloroethylene and a special molding technique to produce an entire series of connectors. Variety includes top- or side-connected leads, with or without resistors.



For further information ask for Application Report E-124

NEW LOWER PRICES FOR "KEL-F" POLYMERS OPEN UP MANY NEW APPLICATIONS POSSIBILITIES!

This is the fourth important price reduction since the introduction of KEL-F polymer products in 1948. It cuts prices up to 25% in ton lots, and as much as 42% for small quantities nominally used for experimental work.

The reduction is made possible by the rapidly expanding acceptance of KEL-F polymers and the manufacturing economies achieved in Kellogg's new production facilities.

NEW PRICE SCHEDULE—Effective May 17, 1954

	High Density	Low Density	Plasticized
1-99 pounds	$10.00	$9.50	$11.00
100-1999 pounds	9.50	9.00	10.50
2000 pounds and over	9.00	8.50	10.00

F.O.B. Jersey City

® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

(SEE REVERSE SIDE)

DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE

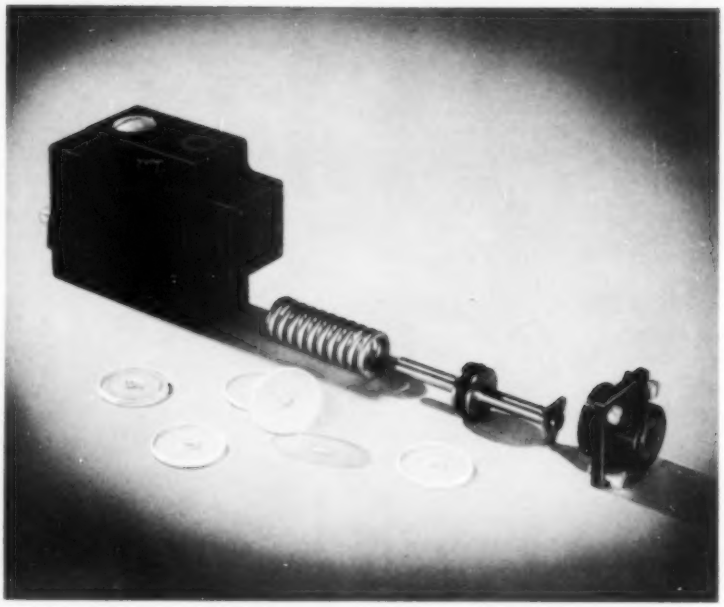
Poppet Valve-seats of KEL-F® Polymer Withstand High Gas Pressures, Repeated Impact in –65°F +160°F Service

Despite air pressures as high as 700 psi and repeated poppet impacts of 45 pounds, air control valve-seats molded of KEL-F polymer now provide seating over time periods in excess of other materials. The material's desirable characteristics of resiliency, impact resistance and dimensional stability are maintained over the entire service temperature range of minus 65°F to plus 160°F. Other critical seat requirements could be satisfied only by this unique fluorocarbon plastic.

KEL-F polymer, tough and resilient over a temperature range of minus 320°F to plus 390°F, takes higher mechanical loads than other seat materials without cracking or distorting.

The Reiss Manufacturing Company, New York, N. Y., molds sheets of KEL-F polymer Grade 300 from which valve seats are made by Air Associates, Inc., Teterboro, N. J.

For further information ask for Application Report P-102



Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F"... each month this column will spotlight several of these companies with their principal services and products.

International Resistance Company
Philadelphia, Pa.
Extrusion, Compression, Transfer & Injection Molding
Terminals, Resistors, electronic components
Extruded Rod & Tube
Molded Rod, Tube & Sheet

Surprenant Manufacturing Company
Clinton, Mass.
Extrusion
Insulated Wire
Extruded Rod, Tube & Spaghetti
Tape, Strip & Monofilament

Tri Point Manufacturing & Developing Co.
Brooklyn, N. Y.
Machining

The United States Stoneware Company
Akron, Ohio
Corrosion Control
Dispersion Coating

Recent Significant KEL-F Polymer Developments...

"Lug" type pressure rupture discs now use extruded film not only to protect discs against corrosion damage, but as pressure and vacuum seals.

Wavemeter test probes (microwave control) use molded insulation for consistent performance in high humidity and under thermal cycling.

Heater coils and plates for severe chemical service are protected with "baked on" coatings of KEL-F polymer dispersions.

Indexed commutators for computors now consist of a molded plastic cylinder with intricate conductive inserts. High dielectric and non-carbonization of polymer improves performance.

Be sure you have the latest BUYERS GUIDE SUPPLEMENT...including new sources for KEL-F polymer parts and services!

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

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Every month Product Engineering lists scores of new catalogs and bulletins available from manufacturers. Some of these cover features of specific equipment. Others contain detailed technical information on selection and application of broad classes of products. All are available to you for the asking.

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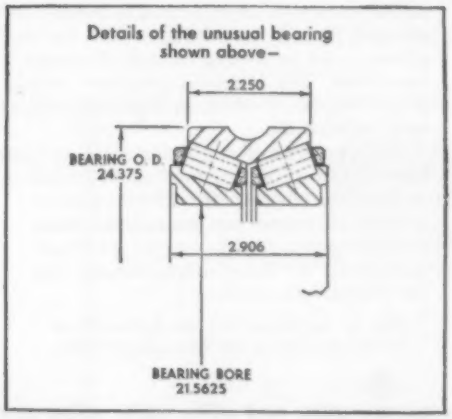

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ber Manufacturers Association and the Multiple V-Belt Drive & Mechanical Power Transmission Association. Also contains a comprehensive explanation of the fundamentals of V-belt design. Selection data on this producer's line of steel cable V-belts is provided.

(14) TUBES, ELECTRONIC—General Electric Co., Schenectady 5, N. Y. Booklet ETR-886, 12 pp, lists recommended receiving and cathode-ray tube types for AM, FM, and television receivers. Compiled in tabular form to cover essentially every requirement of the radio and television manufacturer. Booklet ETD-548C, 20 pp, covers the developmental history of this line of high-reliability receiving tubes for critical applications, and design and manufacturing features of the tubes. Also included is technical data and average characteristics on the 22 miniature and 11 subminiature types currently available. Brochure ETD-892, 4 pp, describes the new high-reliability pentode tube, for critical applications in two-way communications systems. Technical data is included, as well as block diagrams showing application of the new type in existing aircraft and mobile receivers, and a block diagram showing a 152 mc to 174 mc mobile receiver. Booklet ETD-881, 8 pp, describes the metal-and-ceramic "lighthouse" tube, an improved model. The new high-mu triode is designed for use in VHF-UHF circuits as a grounded-grid class C power amplifier, oscillator, or frequency-multiplier, at frequencies up to 2500 mc. Booklet ETD-885, 12 pp, describes three new reference cavities used as frequency-determining references in microwave systems. The booklet covers application information, adaptation to existing equipment and technical data.

(15) RECORDING AND CONTROLLING INSTRUMENTS — Minneapolis-Honeywell Co., Industrial Div., Station 64, Wayne and Windrim Ave., Philadelphia 44, Pa. Bulletin 9050, 28 pp, is a one-source reference for all products of this division applicable to steam generation. Catalog 5001, 24 pp, is a revised composite publication and contains brief descriptions of all this company's instruments. Catalog 2320, 56 pp, includes all types of flow meters made by this division. It contains information on indicating,

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recording, integrating and controlling instruments of both evenly graduated and square root types, as well as area meters and differential converters. Also included is a section on flow approximations and installation information. Bulletin 9604, 8 pp, describes new miniature flame rod assemblies, photocell units, pilots and other components used in combustion safeguard systems for industrial oil and gas burners. Contains specifications, dimensions, application information and price insert.

(16) LIGHT METALS RESEARCH—Aluminum Co. of America, 1501 Alcoa Building, Pittsburgh 19, Pa. Booklet, 54 pp, provides a useful bibliography of technical articles about aluminum, listing more than 1000 books, technical papers, and articles prepared by Alcoa research scientists in the last 35 yr.

(17) EXTENSOMETERS—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. Bulletin 4212, 8 pp. Dial indicating extensometers for many purposes are described, including the "H. F. Moore" and "Tripolitis" units, extensometers for sheet metal and wire, averaging extensometers, compressometers, deflectometers and others with various accessories.

(18) VALVE LUBRICATION—Alemite Div., Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14, Ill. Catalog 22-170, 8 pp, describes lubrication equipment especially designed for the servicing of lubricated valves. Various types of lubrication fittings, which are inserted in the same threads in place of existing lubricant screws on lubricated valves, special extra heavy duty lubrication guns of both lever and bucket types, hose assemblies, follower plates, pressure gauges and other accessories are covered in the catalog and their use explained.

(19) ALUMINUM ELECTRICAL CONDUCTORS—Aluminum Co. of America, 1501 Alcoa Building, Pittsburgh 19, Pa. Booklet, 20 pp, traces the history of this company's conductor research, covering both its pioneering development work and present projects. Among the developments described are all-aluminum cable, steel-reinforced aluminum cable, expanded steel-reinforced aluminum cable, bus

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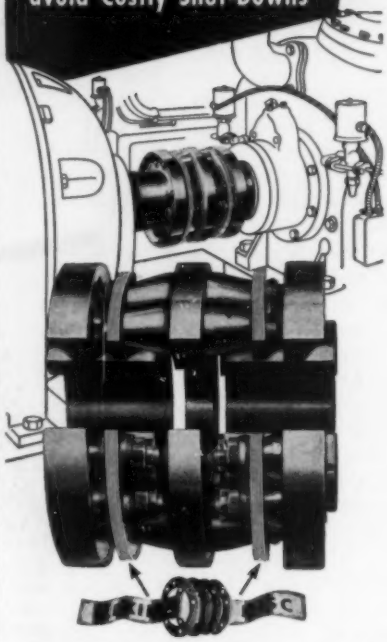

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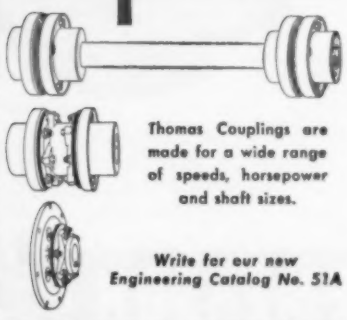

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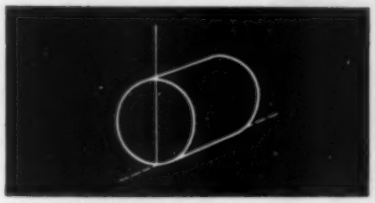

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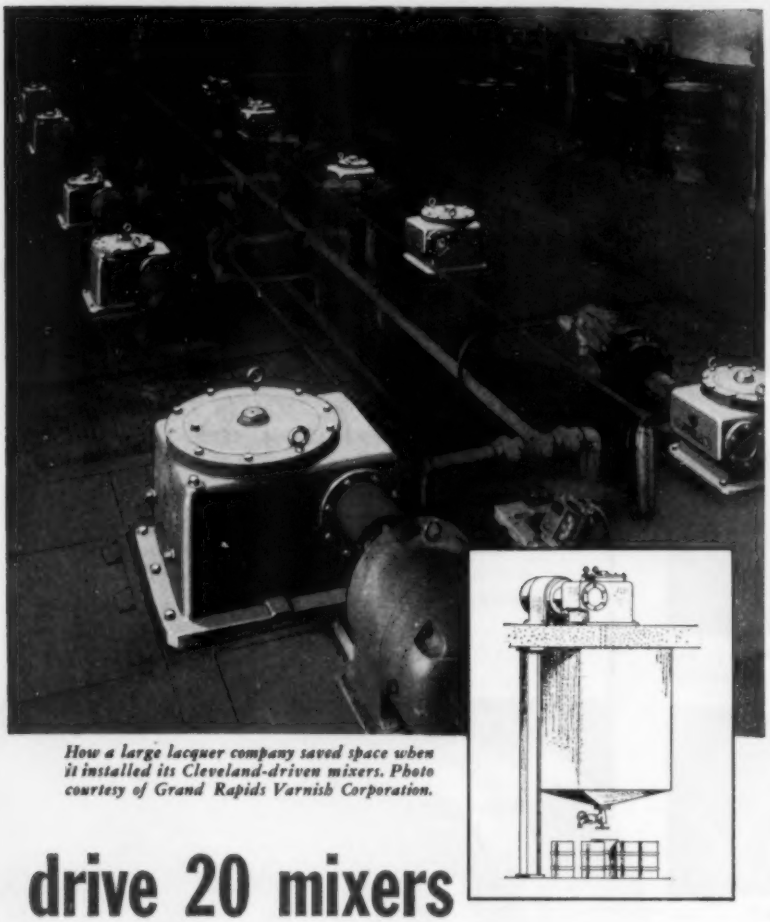

How a large lacquer company saved space when it installed its Cleveland-driven mixers. Photo courtesy of Grand Rapids Varnish Corporation.

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IN a Michigan lacquer factory, the agitators of 20 batch mixing tanks are driven by Cleveland vertical worm gear speed reducers. Motors and drives are mounted on one floor as shown in the photograph, with tanks suspended from the ceiling of the floor below.

This manufacturer chose Clevelands for his mixers because Clevelands transmit power so uniformly and smoothly. The mixing operation is always thorough and dependable. There are no unwelcome speed variations to upset production schedules.

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Smooth efficiency stems from Cleveland's case-hardened steel worms which run in perfect mesh with nickel-bronze gears. This long-wearing combination *actually improves with use*—a fact proven by the record of scores of Clevelands which actually have outlived the machines they drove.

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CLEVELAND
Worm Gear
Speed Reducers

conductor and accessories. Special engineering work carried out on vibration and sag factors is also described. Listings of Alcoa's basic technical reference material on aluminum conductors is also provided.

(20) STEEL AND GREY IRON CASTINGS—Riverside Foundry, Bettendorf, Iowa. Booklet, 14 pp. Includes tables of characteristics and properties of steel casting alloys available from this supplier, together with their chemistries and alterations obtainable by means of heat treating.

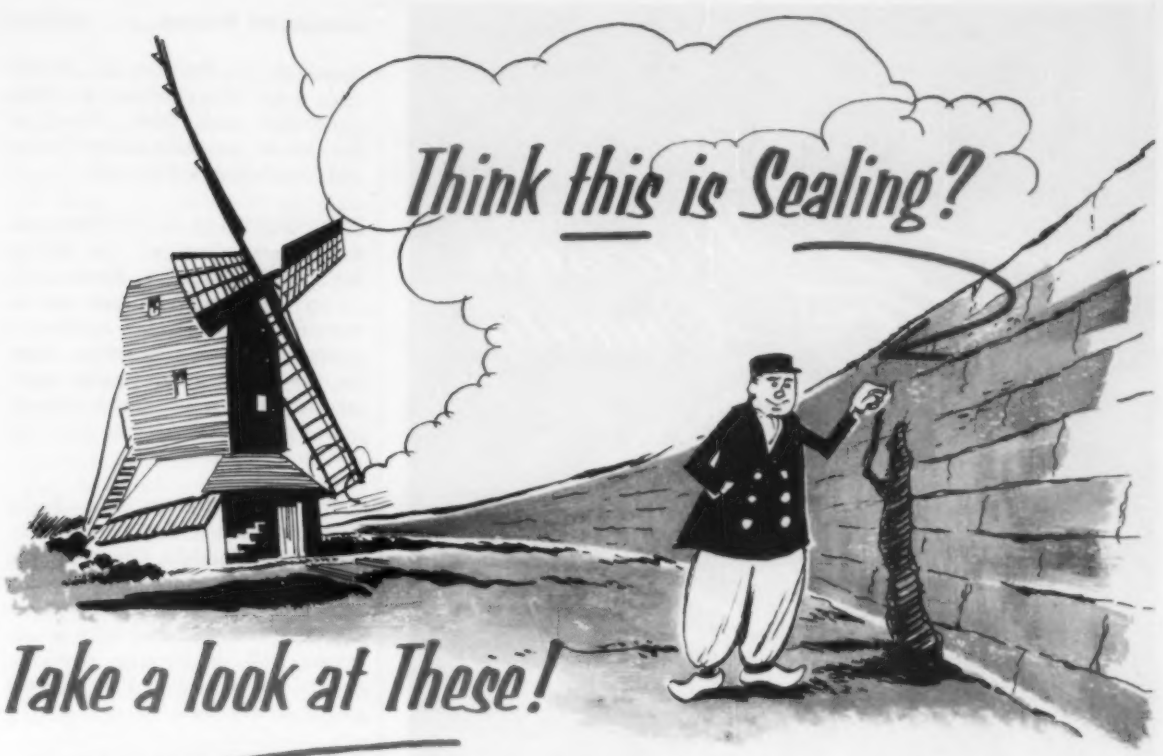
(21) APPLICATION GUIDE FOR SILVER-ZINC BATTERIES—Yardney Electric Corp., 105 Chambers St., New York, N. Y. Complete electrical data and physical dimensions on more than 24 batteries can be obtained from this improved application guide. Included are discharge rates, capacity, weight, height, width, depth, recommended charging rate and voltage and watt hours per pound and per cubic inch at representative current drains.

(22) ROLL SHAFT BREAKAGE—Rodney Hunt Machine Co., Orange, Mass. Report No. 2, 2 pp, is the second one of a series concerned with basic roll engineering data. This report covers the bending moment of shafts. Two different shaft designs are compared with respect to stress concentrations and breakage at these points.

(23) HYDRAULIC CONTROLS—Pantex Mfg. Corp., Pawtucket, R. I., Bulletin 57, 6 pp, describes ¾-in., pilot-operated, four-way valves. They have a pressure range from 100 to 5000 psi. This unit has the same main body as this maker's solenoid controlled model. Specification and application data are included.

(24) INSTRUMENT TRANSFORMERS—R. E. Uptegraff Mfg. Co., Scottdale, Pa. Catalog, 30 pp, provides performance data, dimensional drawings, tables showing costs and weights for various ratings. Data is given on transformers for 15 types of applications, and a section is devoted to standard requirements for instrument transformers.

(25) SNAP-ACTION SWITCHES—Micro, Div. of Mineapolis-Honeywell



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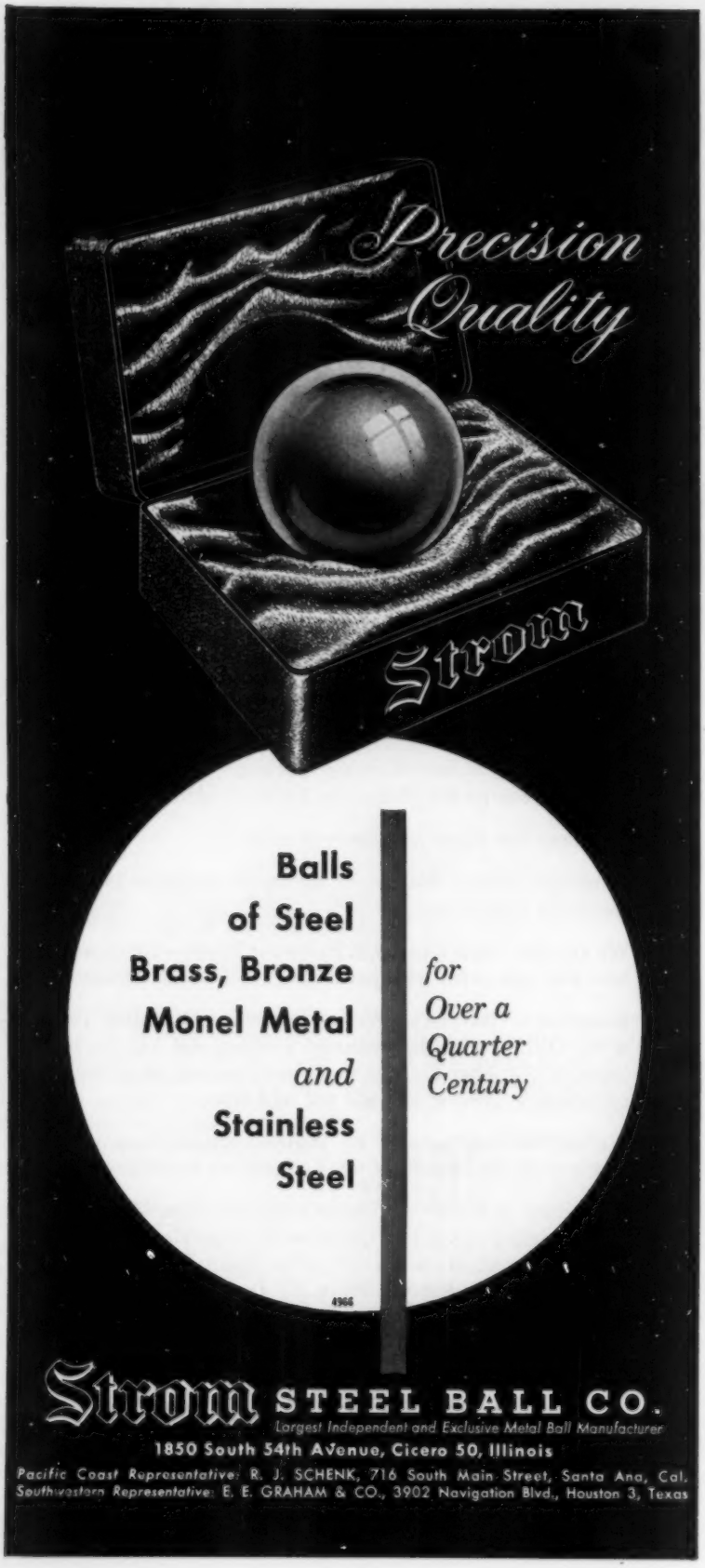
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Catalogs and Bulletins.....continued

Regulator Co., Freeport, Ill. Bulletin 54A, 4 pp. Characteristics, functions, dimensions and other details of switches for automatic safety, limiting and interlocking applications.

(26) SELENIUM RECTIFIERS—Radio Receptor Co., Inc., 251 W. 19 St., New York 11, N. Y. Bulletin 177, 24 pp., describing both radio and industrial types of selenium rectifiers, is illustrated with voltage curves, circuitry, tabular matter and product applications. There is an expanded tabulation of power rectifiers up to 260 input and 30 amp.

(27) SPEED REDUCERS—Euclid Universal Machine, Inc., 29930 Lakeland Blvd., Wickliffe, Ohio. Catalog, 28 pp. Single and double-reduction and mitre-type speed reducers are described and illustrated with photographs and engineering drawings. Curves for torque and horsepower ratings are also included.

(28) CONVOLUTED COUPLINGS—Solar Aircraft Co., 2200 Pacific Highway, San Diego 12, Cal. Catalog 55, 16 pp. Engineering data, with spring rates, deflection forces and dimensions, are given on a new line of expansion joints for low pressure and vacuum service. Included are ten pages of tables giving complete data on each size and type of coupling, along with dimensional diagrams and a group of formulas for calculating various movements of couplings.

(29) MEASURING AND CONTROL EQUIPMENT—Simplex Valve and Meter Co., 68 and Upland St., Philadelphia 42, Pa. Bulletin 004, 36 pp. lists equipment for the measurement and control of liquids and gases. Illustrated are types of controllers. gauges, manometers, recorders, meters, valves, Venturi tubes. All are applicable for water and sewage works, power and processing industries.

(30) DESK AND CABINET ASSEMBLIES—Par-Metal Products Corp., 32-62 49 St., Long Island City 3, N. Y. Catalog, 8 pp, describes a group of standardized, interchangeable desk or cabinet units, the combination of which is adaptable for control stations, testing apparatus, sound distribution systems and similar applications. Dimensions and applications and il-

lustrations of the following nine standardized units are included: desk panel cabinets (single, double or triple units), table tops (single, double and triple units), pedestals (available plain less doors and panels, with plain door and with ventilated door), end pedestal and floor brace, formed rack panels, mounting bracket, rack type chassis, shelf, sliding drawer.

(31) PROPERTIES OF CASTINGS —Meehanite Metal Corp., 714 North Ave., New Rochelle, N. Y., Calculator type of chart provides the engineering characteristics of all metals in the four major classifications under which this company's castings are produced.

(32) PLASTICS MOLDING—Bakelite Co., 300 Madison Ave., New York 17, N. Y. External house organ, 4 pp. The purpose of the new periodical is to inform plastics molders of new developments in this company's resins and compounds. In the first issue, photographs of molded parts, supported by property data tables and by case histories from the industrial molders, illustrate the economic advantages of a new general-purpose, phenolic molding compound, BMG-5000.

(33) CABINET DRAWER SLIDES —Grant Pulley & Hardware Co., 31-85 Whitestone Parkway, Flushing, N. Y. Catalog describes slides made for electronic equipment consoles, chassis, racks. Chart of characteristics and design details for easier selection. Included are engineering drawings of the various types of slides.

(34) ELECTRIC VALVE OPERATORS—McBain Corp., 6251 W. Century Blvd., Los Angeles 45, Cal. Catalog T-81, 8 pp, describes a means of operation of all types of conventional gate, globe, plug, butterfly and other valves, in sizes from 2½-in. Valve operators in three basic sizes with ¼ to 3 hp motors are illustrated and specifications are given in detail.

(35) FRICTION MATERIALS — Raybestos-Manhattan, Inc., 6010 Northwest Highway, Chicago 31, Ill. Bulletin 500, 44 pp. Brake linings and blocks, clutch facings, friction materials in special shapes and sintered metal friction materials are described. Service conditions under which various materials for such parts will

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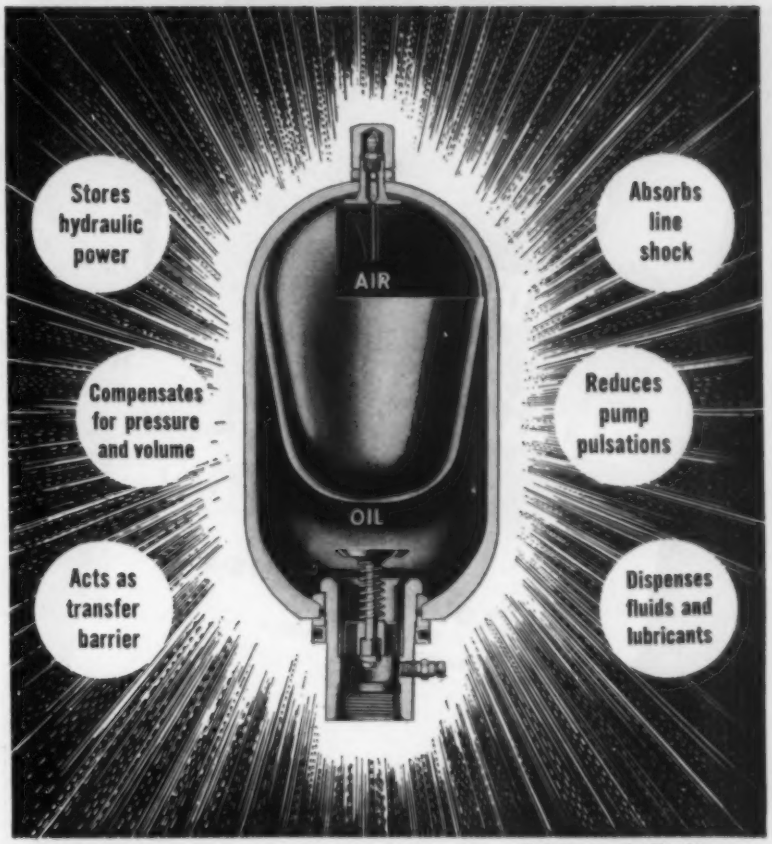

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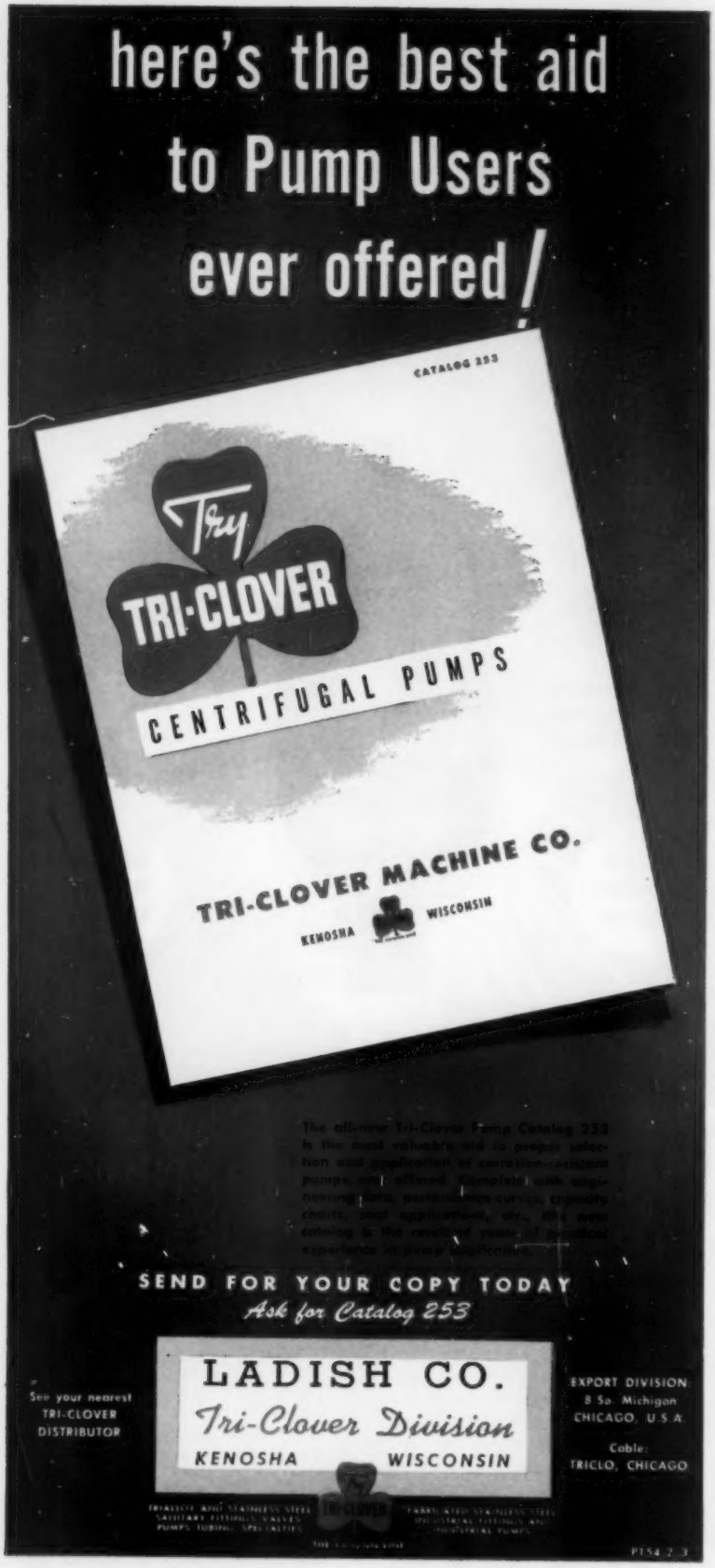


operate are analyzed. Design data on selection of materials for operation in oil and for dry applications is included.

(36) TEMPERATURE CONTROLS—Burling Instrument Co., 16 River Road, Chatham, N. J. Bulletin 102, 2 pp, covers Models V-1C and V-1X, which are primarily used for high temperature safety alarms and cut-outs up to 1800 F. Included are complete descriptions of operation, dimensions, methods of mounting and operating specifications.

(37) PORTABLE GASOLINE ENGINES—Power Products Corp., Grafton, Wis. Booklet contains descriptions and illustrations, including some cutaway views, of 2-cycle engines for industrial applications.

(38) HEATED AND COOLED GAGES AND VALVES—Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass. Bulletin 237, 4 pp, covers problem of getting accurate level readings of liquids that boil or surge, or liquids that are heavy and don't flow at normal temperature. Special design and construction features are described and illustrated.

(39) MAGNETIC RELAYS — Essex Wire Corp., Logansport, Ind. Bulletin, 4 pp, shows the various types of open and hermetically sealed a-c and d-c relays in this company's line. General characteristics, including maximum coil resistance and power requirements, contact forms available, approximate weight and dimensions, are included.

(40) LUBRICANTS — Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N. J. Booklet, 36 pp, discusses lubricant selection and lists recommended oils and greases of this company's manufacture for various applications.

(41) WIRE AND CABLE INSULATION—United States Rubber Co., Rockefeller Center, New York 20, N. Y. Booklet, 140 pp, contains chapters on insulation compounds, jacket compounds, service cables, street-lighting cables, power cables, control cables, power and lighting wires and cables, bare and weatherproof wires and cables, portable cords

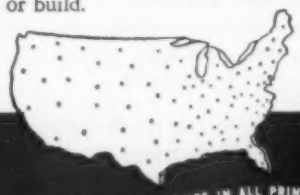
Write for your copy of SEALMASTER Catalog 454.

SEALMASTER
BALL BEARING UNITS

SEALMASTER BEARINGS

A DIVISION OF STEPHENS-ADAMSON MFG. CO.
9 RIDGEWAY AVENUE, AURORA, ILLINOIS

Features like the patented *Locking Pin* and *Perimeter Dimple* have kept SEALMASTER Bearing Units *well ahead* of demands for high speed production in the current trend toward automation. SEALMASTER leadership has set a new standard for low-cost in bearing maintenance and maximum bearing efficiency. It will pay you to consider the advantages of SEALMASTER Bearings in the machines you buy or build.



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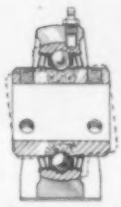
SEALMASTER'S
Patented
LOCKING PIN & PERIMETER DIMPLE

Rotation of outer race ring in the bearing housing is prevented . . . **eliminating housing wear.**

Locking Pin locates the lubricating hole within the *Dimple* on the outer race ring and has a V-shaped groove at each end to allow a free flow of grease from the grease fitting to the sealed bearing chamber . . . **assuring positive lubrication.**



Locking Pin and *Dimple* allow several degrees of misalignment in any direction. **Misalignment of shaft cannot interfere with the effectiveness of the seal.**

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Factory Set
Timer Relays

FACTORY SET, TAMPER-PROOF TIMING

Practically non-breakable, Durakool **Factory Set Timer Relays** have more than proved themselves on the roughest and toughest jobs that could be found. Year by year, their use increases in sensational fashion.

Controlled time available from .15 to 20.0 seconds in either normally open or normally closed actions. No waiting. Your production schedule is met.

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★ No chatter
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Durakool ALL-STEEL MERCURY *Timers*

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When it can't be readily serviced—that's another WATERMAN FLOW REGULATOR STORY.

Yale & Towne install WATERMAN FLOW REGULATORS inside the lift cylinders on all their fork trucks. Only products rendering years of trouble-free service are installed where they would not be readily accessible for servicing.

WATERMAN FLOW REGULATORS can give you years of trouble-free automatic flow regulation and at the same time reduce weight, space and cost while simplifying your hydraulic circuits.

Available in a range of sizes and a variety of models to take care of your requirements.

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Waterman ENGINEERING COMPANY
725 CUSTER AVENUE • EVANSTON, ILLINOIS

and cables and insulated aluminum conductors. Complete descriptions, including engineering data, are given on each product.

(42) GENERAL PURPOSE PACKINGS—United States Gasket Co., Camden 1, N. J. Catalog. Products illustrated and described are braided pure Teflon and braided Teflon-impregnated blue or white asbestos available in coils and cut rings. Extruded packing and bulk packing of this compound also included.

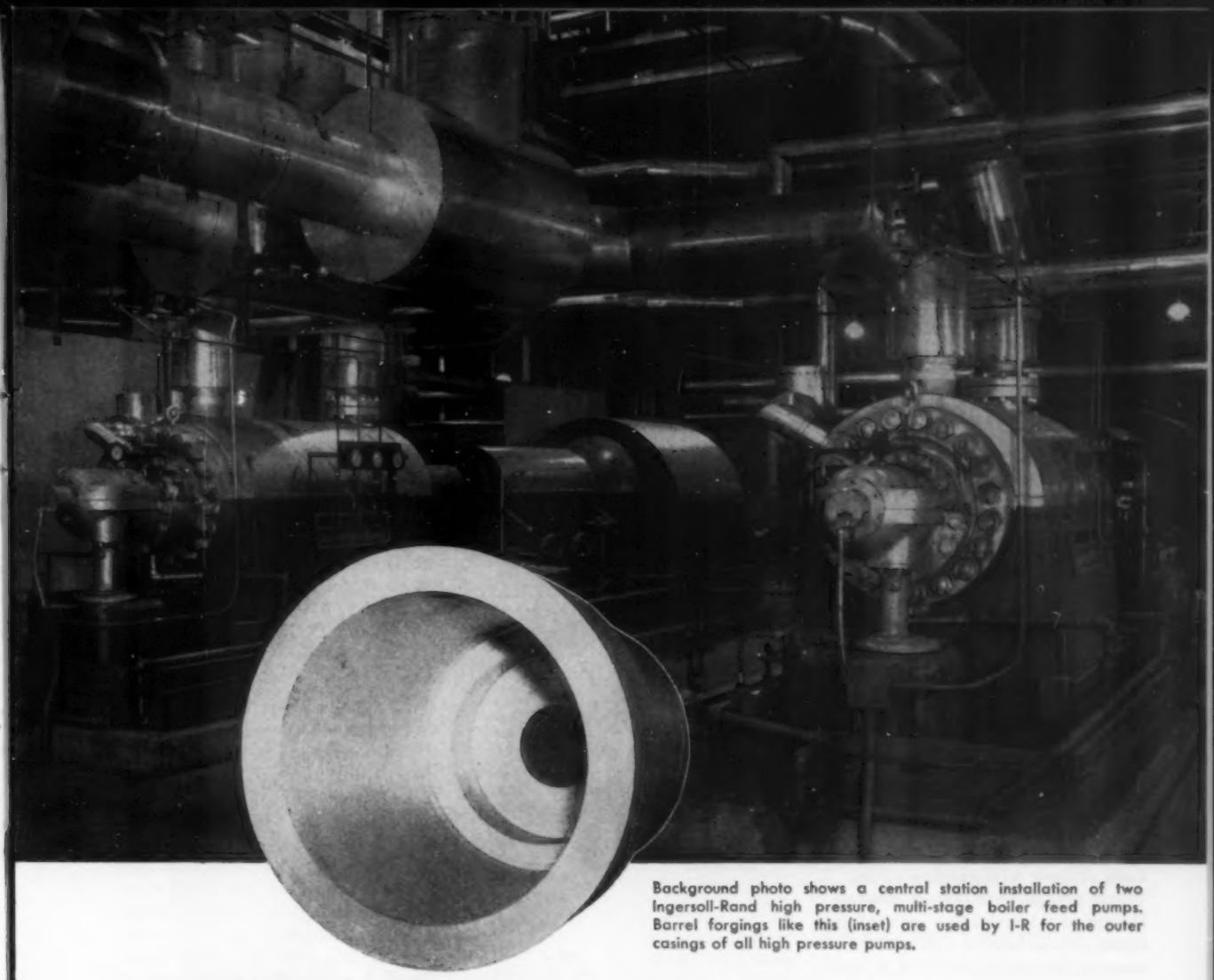
(43) TORQUE LIMITERS—Morse Chain Co., 7601 Central Ave., Detroit 10, Mich. Catalog C14-54, 8 pp, gives complete design and operation information as well as specification tables for a line of eleven standard models having torque capacities ranging from 20 to 620 ft-lb.

(44) SELENIUM RECTIFIERS — Fansteel Metallurgical Corp., N. Chicago, Ill. Bulletin 6.400, 24 pp, contains standard cell sizes and ratings, typical rectifier circuits, formulae and constants, elementary operating principles, typical characteristic curves, typical test circuits, operation of rectifiers at higher than normal temperatures, installation and care, typical applications with circuit diagrams.

(45) MOLDED PLASTICS — Chicago Molded Products Corp., 1023 N. Kolmar Ave., Chicago 51, Ill. External house organ, 8 pp. This first issue of new periodical contains application stories on molded plastic parts made by this company.

(46) HEAVY DUTY CLUTCH—Lipe-Rollway Corp., 806 Emerson Ave., Syracuse, N. Y. Type DP Manual, 12 pp, describes construction and operation of new direct-pressure dry-disc, push-type clutch for heavy duty service on off-the-highway vehicles, buses and trucks. Contains chart listing pressure spring and pressure plate data. Cut-away photos detail major clutch components.

(47) CAPACITORS, BUTTON-TYPE—Sangamo Electric Co., Marion, Ill. Catalog 830 A, 24 pp. Similar styles of these silvered mica capacitors are grouped together according to the arrangement of terminals. Engineering drawings of each model are actual size.



Background photo shows a central station installation of two Ingersoll-Rand high pressure, multi-stage boiler feed pumps. Barrel forgings like this (inset) are used by I-R for the outer casings of all high pressure pumps.

Ingersoll-Rand tells how:

STEEL FORGINGS HELP GIVE LONG LIFE TO HIGH PRESSURE BOILER FEED PUMPS

Ingersoll-Rand Class CHTA boiler feed pumps are widely used in high pressure central power generating stations throughout the world. They are double-case units, the inner assembly containing the rotor and fluid passages and the outer casing providing the pressure vessel to enclose this pumping unit.

For service under high pressures and temperatures, Ingersoll-Rand uses steel forgings for the outer casing of these boiler feed pumps. Since Standard Steel forges these outer barrels from solid billets of high carbon steel, they have a close grained, homogeneous structure. That's a big reason why Ingersoll-Rand double-case pumps have established a reputation for long, trouble-free service with sustained high efficiency.

Very likely, you can improve *your* products by using Standard Steel barrel forgings, rolled rings, flanges or other forgings. Our engineering and metallurgical departments have helped solve many diverse problems. Please write us about yours.

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MEETINGS

July 13-15

WESTERN PLANT MAINTENANCE SHOW, Los Angeles, Pan Pacific Auditorium. Solutions to maintenance problems peculiar to Pacific states industrial operations will be emphasized. At the opening session the discussion will be on maintenance organization, management, planning, scheduling and training personnel. The balance a series of sectional conferences.

July 27-28

INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS, 4th General Assembly, Brussels, Belgium. Address queries to: Dr. Hugh L. Dryden, 1724 F Street, N. W., Washington 25, D. C.

Aug. 2-13

A SURVEY OF THE FIELD OF ANALOG COMPUTATION will be given in a special summer program at the Massachusetts Institute of Technology by the Dynamic Analysis and Control Laboratory. The program will be directed by Dr. John A. Hrones of this department, who says that the idea behind it is to introduce analog techniques to those not working directly with such computers, and to broaden the knowledge and outlook of those already familiar with certain aspects of machine computation.

Aug. 9-11

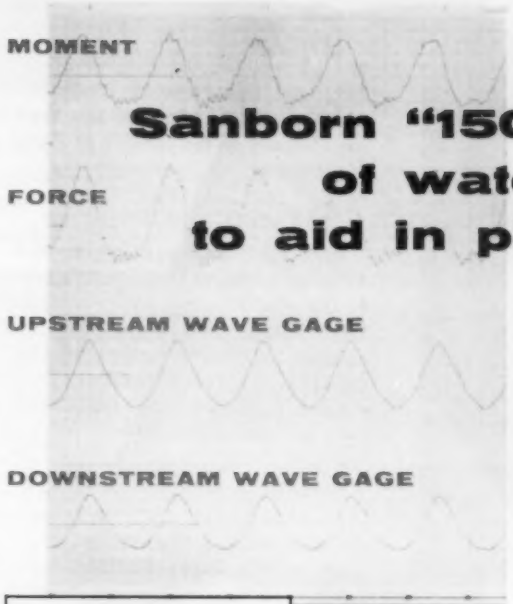
INSTITUTE OF THE AERONAUTICAL SCIENCES, Turbine-Powered Air Transportation Meeting, Seattle, Wash.

Aug. 23-Sept. 3

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass. A two-week special summer program in the Automatic Control of Machine Tools. Morning Sessions will be devoted to studies of systems and components. Afternoon sessions will cover programming techniques, using the numerically controlled milling machine developed in the servomechanisms laboratory. Tuition is $160.

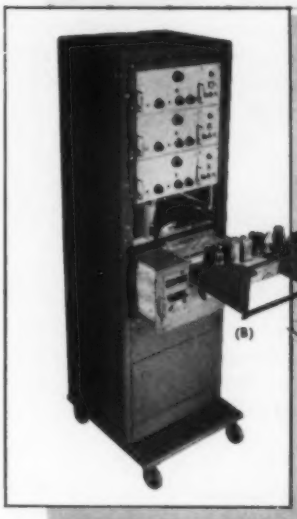
Aug. 25-27

WESTERN ELECTRONICS SHOW & CONVENTION, Los Angeles Pan-Pacific Auditorium. The show and conven-



Sanborn "150" records the effects of water wave forces to aid in pile structure design

By means of a Sanborn 150 Oscillographic Recording System equipped with four carrier type preamplifiers, engineers at the M.I.T. Hydrodynamics Laboratory are getting accurate pictures of simulated shallow water waves and their effect on dummy piles. The shape and length of precisely controlled waves in a 90 foot glass flume are plotted simultaneously with their moment and force on a suspended cylindrical pile. The excellent frequency response available with this method permits a sensitivity and accuracy not obtainable in previous model studies of this type.



Preamplifier (A) in position to plug into a driver amplifier with frame, combined with power supply and control panel (B) which is normally already in place in the basic cabinet assembly.

This is but one of MANY applications possible with Sanborn 150 Oscillographic Recording Systems

Virtually all electrical phenomena, within a frequency range of zero to 100 cps, can be accurately, permanently and graphically registered by Sanborn Oscillographic Recording Systems. This versatility of application is possible because of the *flexibility* of Sanborn 150 Series Recording Systems. A wide variety of quickly *interchangeable* pre-amplifiers, which plug in to *built-in* driver amplifiers (illustrated at left), are available for use with Series 150 Systems, to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation, tension, and power.

Add to this versatility the Sanborn features of inkless tracings in true rectangular coordinates, on plastic coated chart paper . . . high torque movement . . . time and code markers . . . numerous chart speeds.

Let Sanborn Answer YOUR Recording Requirements

For informative technical data on the basic 1, 2, and 4 channel Sanborn systems, and qualified counsel to help you select the correct Sanborn equipment for your requirements, write to

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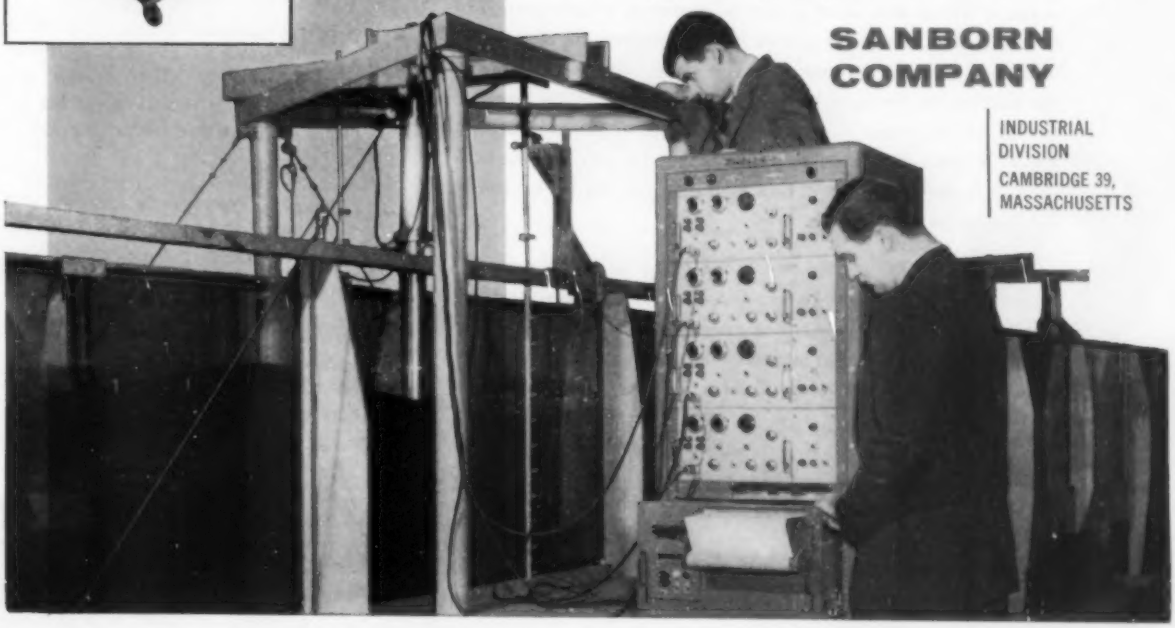
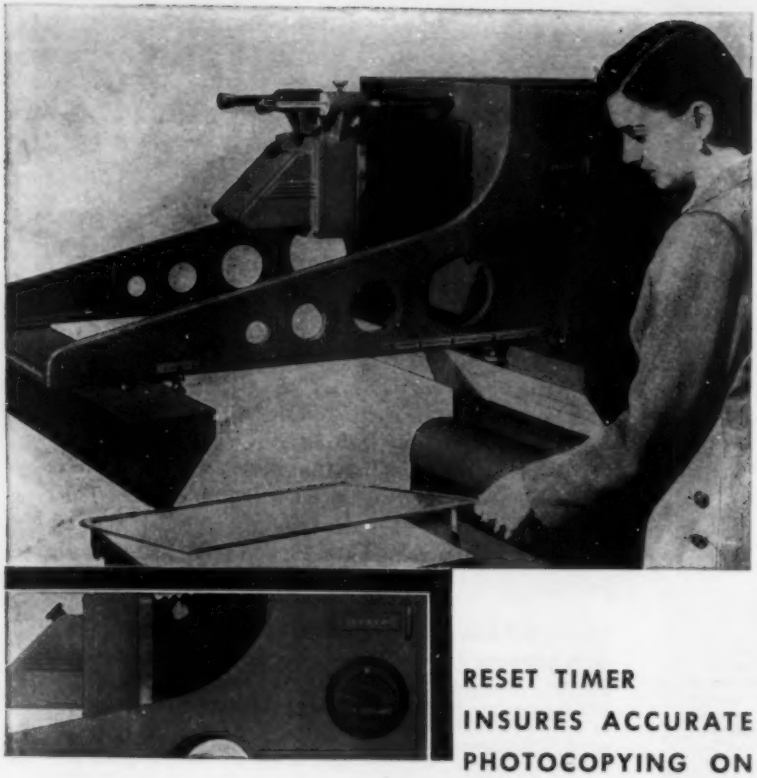
CAMBRIDGE 39, MASSACHUSETTS





RESET TIMER INSURES ACCURATE PHOTOCOPYING ON REMINGTON RAND DEXIGRAPH

An outstanding feature of this versatile photocopying machine is the Cramer Reset Timer, which controls exposures to split-second accuracy and ensures copy prints of absolutely uniform quality. The Type RE Reset Timer is an ideal choice for this application. Its micrometer adjusting dial allows time settings to be changed easily and quickly; yet setting can be made to a high degree of accuracy. A double pointer system is used which indicates not only the time setting but also the time remaining during any particular cycle. The push-button for starting the timing cycle is right on the front of the timer; a flick of the finger controls the machine. The convenient one-hole meter-type mounting also makes for easy assembly in your factory. Note, too, how well the timer blends in with the design of the machine itself.

Remington Rand is only one of the many large equipment manufacturers who look to Cramer when they have a problem in time control. Cramer has a timer for almost any need, ranging from the simplest interval timers up to complex multi-circuit types. Why not consult Cramer for your timing needs?

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

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tion are sponsored by The West Coast Electronic Manufacturers Association and The Los Angeles and San Francisco sections of the Institute of Radio Engineers.

Aug. 30-Sept. 3

SIXTY-THIRD ANNUAL CONVENTION & TRADE SHOW OF THE PHOTOGRAPHERS ASSOCIATION OF AMERICA, Conrad Hilton Hotel, Chicago, Ill. Theme of affair is the rapid growth of photography as a tool of industry. Print exhibits, demonstrations, and discussions on newest techniques.

Sept. 1-16

INTERNATIONAL ELECTRO-TECHNICAL COMMISSION, University of Pennsylvania, Philadelphia, Pa. The Golden Jubilee Meeting. The commission seeks a better understanding between electrical engineers of various countries with common means of expression and standards for electrical machinery.

Sept. 8-10

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fall Meeting, Milwaukee, Wis.

Sept. 13-16

SOCIETY OF AUTOMOTIVE ENGINEERS, National Tractor Meeting & Production Forum. Hotel Schroeder, Milwaukee, Wis.

Sept. 13-25

FIRST INTERNATIONAL INSTRUMENT CONGRESS & EXPOSITION, Philadelphia, Pa. Technical sessions will run through this period, while the exposition will open on Wed. the 15th.

Sept. 28-Oct. 1

ASSOCIATION OF THE IRON AND STEEL ENGINEERS. Iron and Steel Exposition, Public Auditorium, Cleveland, Ohio.

Oct. 4-6

NATIONAL ELECTRONICS 10TH ANNUAL CONFERENCE, Hotel Sherman, Chicago, Ill.

Oct. 5-9

SOCIETY OF AUTOMOTIVE ENGINEERS, National Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display. Hotel Statler, Los Angeles, Calif.

SEALTITE
ELECTRICAL CONDUIT PROTECTS WIRING

against oil, grease, water, dirt, chemicals, corrosive fumes, salt spray, weather

SEALTITE* is a flexible *and* liquid-tight electrical conduit. It gives maximum protection to your wiring when it must connect moving parts, absorb vibration, follow machine contours, flex into U-bends, be easily maintained or be safeguarded between misaligned ports.

It is being used successfully in wet locations, in tunnels, power plants, steel mills, canneries, chemical industries and in many outdoor applications. SEALTITE comes in two types:

TYPE U. A.—UL-approved. Made with flexible galvanized steel core, positive ground and tough outer cover.

NOM. I.D. (Inches)	INSIDE DIA. (Inches) Min.	INSIDE DIA. (Inches) Max.	OUTSIDE DIA. (Inches) Min.	OUTSIDE DIA. (Inches) Max.	APPROX. INSIDE BEND DIA. (Inches)	EST. WEIGHT per hundred ft. (Pounds)
⅜	.484	.504	.690	.710	8	30.0
½	.622	.642	.820	.840	10	36.6
¾	.820	.840	1.030	1.050	15	48.2
1	1.041	1.066	1.290	1.315	18	87.7
1¼	1.380	1.410	1.630	1.660	21	116.5

TYPE E. F.† (Extra Flexible)—for machine tools and industrial equipment. (Meets standards set by J.I.C.) †Pat. Applied For

NOM. I.D. (Inches)	INSIDE DIA. (Inches) Min.	INSIDE DIA. (Inches) Max.	OUTSIDE DIA. (Inches) Min.	OUTSIDE DIA. (Inches) Max.	APPROX. INSIDE BEND DIA. (Inches)	EST. WEIGHT per hundred ft. (Pounds)
⅜	.485	.505	.690	.710	5	24.3
½	.620	.640	.820	.840	6	29.0
¾	.815	.835	1.030	1.050	9	38.2
1	1.025	1.055	1.290	1.315	10	65.0
1¼	1.365	1.395	1.630	1.660	13	84.4
1½	1.575	1.605	1.870	1.900	15	122.0
2	2.020	2.055	2.335	2.375	17	158.0
2½	2.480	2.515	2.840	2.875	20	205.0
3	3.070	3.110	3.460	3.500	27	290.0
4	4.000	4.050	4.460	4.500	34	430.0

Commercial tolerances apply on above figures.

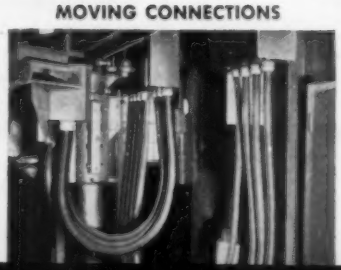
ELECTRICAL WHOLESALERS stock both types. Buy it in long random lengths as shown; then cut without waste. Or ask your wholesaler to cut the length you need. Liquid-tight connectors are available from wholesalers' stocks. Write for Bulletin UA-531. *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.*

*Trade Mark 54175

SEALTITE flexible, liquid-tight electrical conduit an **ANACONDA®** product

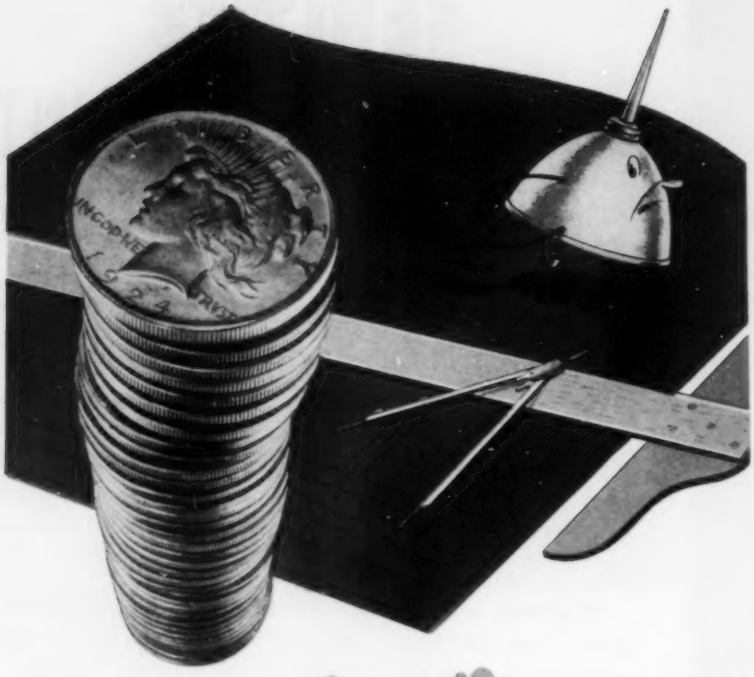
FOR WET SPOTS

MOVING CONNECTIONS



OUTDOORS

MISALIGNMENT



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When you design a machine to include Bijur Automatic Lubrication as an integral component, the user profits many ways. Costly hand oiling is eliminated. Repair bills are substantially reduced. Productive capacity is increased because machines are lubricated while in operation; downtime is reduced. Every bearing receives the right quantity of oil at the right time. There are no starved or flooded bearings. In your customer's plant, safety is increased; fire risk is lessened; personnel injuries are avoided. All this adds up to greater sales appeal for your machines.

For more than a quarter of a century, machine manufacturers have looked to Bijur as the accepted standard of automatic lubrication. Well over a million Bijur Systems have already been installed. Let Bijur design a custom-engineered lubrication system for you, to fit machines now in production or in the planning stage.

Literature and engineering data are yours for the asking.

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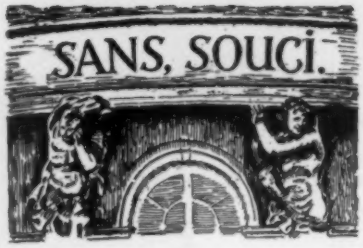
Rochelle Park, New Jersey

Pioneers in Automatic Lubrication



Ad Libbing by the Editor

Back in the days when I was teaching, the senior mechanical engineering students would have a party shortly before their graduation. They would invite all of the members of the mechanical engineering staff and we always had a gay old time.

At that dinner it was the custom for each of the faculty members of the mechanical engineering department to speak a few words. Of course it was a very jovial party and no matter what the prof said there was always plenty of ribbing and fun.

Now it happened that I read a little story in some popular magazine or other that seemed to fit the occasion and the last year that I was teaching I told this story to the senior students who were to be graduated the following Monday. Here is the story:

Isaac was the son of a rather large family. Contrary to general expectations, Isaac was extremely dumb. It seemed to be absolutely impossible for him to learn anything. Eventually his father became extremely exasperated and seeing a "Help Wanted" ad he spoke to Isaac.

"Isaac," said he, "Here is an advertisement for a church sexton. You are big and strong for your fifteen years of age so you should be able to do the job. Now go and get it."

Dutifully Isaac went after that job. The parson saw before him a husky youngster who certainly would be able to cut the grass, sweep the sidewalk, shovel the snow, ring the church bell and shake the furnace. He liked the boy's enthusiasm and his obvious physical abilities. So he offered him the job.

"Now, Isaac," said the parson, after he had given the boy the job, "There is one thing you must do. Every morning as soon as you get here I want you to walk through the church and I want you to observe the torn carpet, any breaks in the pews and benches, try out the lights and notice which ones are burned out and be sure to notice anything else that needs fixing. Then I

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By specializing exclusively in *Fine Gears Made to Order* for thirty-five years, Fairfield has become one of America's largest producers of these parts. Fairfield's facilities are unexcelled. Here "under one roof" in a new and ultra-modern plant designed especially for the purpose, Fairfield has everything needed to produce your gears EFFICIENTLY, ECONOMICALLY. *Call or write for information TODAY.*
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2305 SOUTH CONCORD ROAD
LAFAYETTE, INDIANA

Sans, Souci .....continued

want you to go to my study. There will be a pad of paper and a pencil on my desk and I want you to write down everything that needs fixing."

"Oh Parson," said Isaac, "I can't do that."

"You cannot do it! Why not?" replied the parson.

"Well, I can't read and I can't write so I can't write down what needs fixing."

"I am sorry, Isaac, I must have that report every morning. Therefore I will have to take back my offer. Because you cannot write and read you cannot have this job as church sexton."

Isaac went back to his father who in a rage gave him a card of collar buttons and told him to go out and sell them. A short time later Isaac was back for another card of collar buttons. A few days later Isaac was walking the streets with a tray hanging from his neck selling shoe laces, pencils, safety pins, collar buttons and sundry other articles. The months rolled by and Isaac had a push cart and finally a little store.

It was about 30 years later. Isaac was then a prosperous looking business man in his middle forties and owner of the biggest department store in town. One day he went to his banker and presented to him what he thought was a wonderful idea. Said he:

"Mr. Banker, I have a big idea. You know these farmers around town when they have some big shopping to do, they don't come into this town to do their shopping. They go to the big city fifty miles away.

"I want to put in a beautiful new store front. I will put in modern fixtures, modern lighting and completely new interiors. I will also add a full line of men's clothing and furniture and ladies' dresses. I will give this town a fine department store that will have everything that the big-city stores have. Then the people will come into this town to do their shopping instead of going to the city fifty miles away. And they will buy things from me and will also buy things from the other stores in town instead of buying those things in the big-city stores."

The banker listened. He said it was a wonderful idea. He said to Isaac, "Go ahead and do it. It will be the greatest thing that ever hit this town."

"Sure," said Isaac, "But I will need $100,000."

"That's all right," said the banker,

"We have been watching you. You are a great merchant. We have every confidence in you. We will back you up with $100,000. Just wait a few minutes and we will have the papers made out."

The banker called in one of his men and told him to make out the necessary papers. While waiting for them the banker and Isaac had some idle conversation. Finally the papers arrived. The banker scanning them carefully, pushed the papers across the desk to Isaac and said, "Now just sign your name, Isaac, and we will credit your account with $100,000 whenever you want it."

Isaac reached over, picked up the pen and with great deliberation put an X in the place for his signature. The banker quickly said, "No, no, Isaac, sign your name."

"That's my name," said Isaac. "I cannot read, I cannot write, I put down an X, you have some witnesses and that's my signature."

"What!" exclaimed the banker. "You cannot read and cannot write and you are the biggest merchant in this county. Why, Isaac, if you could read and write you would be the biggest merchant in this country."

"No, no," exclaimed Isaac. "If I could read and write I would be a church sexton."

I always closed my speech with this admonition:

"Men, in a few days you will be receiving your degree. Remember, in so far as society is concerned the value of that degree is less than the cost of the sheepskin. Your value to society is determined entirely by the value of services rendered. It will be necessary for you to back up your degree with experience plus enthusiastic ambitions and a sense of values."

Decades later, when I would meet with some of the former students who had heard that story they would remind me of it.

Cunning versus Intelligence

It is only human to make tremendous mistakes in judging others. The greatest mistakes in business are those resulting from the failure to correctly analyze a person's mental ability, actions and reactions. All of these three are tightly woven together, so tightly that they must be considered as a unit. That unit is usually called character.

...How about Malleable?

Versatile Castability Permits Wide Freedom of Design

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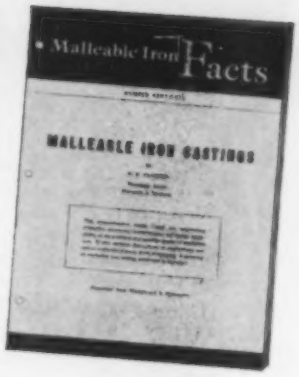

Free Design and Application Data to Help You Design with Malleable

This issue of Malleable Iron Facts contains valuable data on grades, design and application of malleable iron to aid the design engineer.

Ask your malleable castings supplier for copies or write to the Malleable Founders' Society

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Sans, Souci .....continued

It is the sum of distinctive mental and moral attributes of the individual.

Merely because a man is clever or shrewd does not mean that he has outstanding mental abilities. Some of the greatest brains of history were possessed by men who were neither clever nor shrewd. They were men who were so realistic and so educated to truth that they they neither possessed, nor attempted to practice, cunning or shrewdness.

The same thing can be said with reference to education. One of the finest educated men with whom I ever worked sold newspapers on the streets of Chicago when he was 12 years old. He had left school to support his widowed mother.

Though I was a college graduate and presumably well educated I was amazed at the knowledge of history possessed by Paul Campbell, the man to whom I refer. His english was perfect. His diction was beautiful and his knowledge of history and the great personalities thereof was truly amazing. He often made me feel ashamed of my limited knowledge of history.

Another man with whom I had many contacts and who likewise stopped his formal education at about 12 years of age was entirely different from Paul Campbell. His education had practically ceased when he left school but he possessed tremendous shrewdness and had uncanny business sense and everything that he touched turned to gold.

Both of these men had one thing in common. Both had high moral standards. However, it is not always true that the shrewd person has high moral standards.

It is extremely easy to misjudge a person. Cunning is often mistaken for mental brilliance. Shrewdness often appears to be indicative of great analytical powers. Only too often a shrewd person is actually unprincipled and quite lacking in the power of mental analysis.

Cunning, shrewdness, clever repartee, quick comebacks and similar characteristics are not necessarily indicative of high mental ability. The power to reason, analyze and calculate is almost invariably accompanied by a calm demeanor, a quiet voice, precise expression, penetrating observations and decisive conclusions.

Of course, it takes all kinds of people to make this world. —G.F.N.

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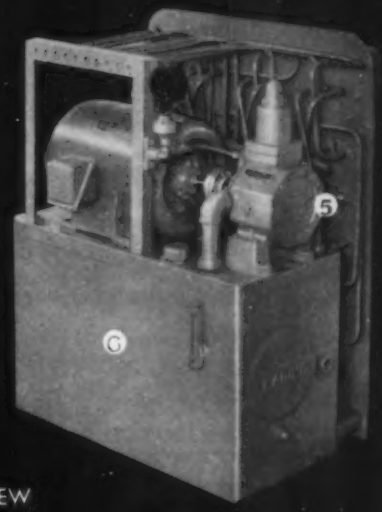

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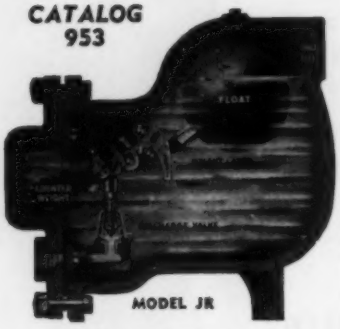

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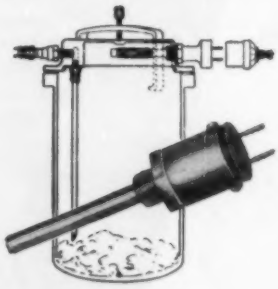

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ENGINEERING ABSTRACTS

Where Dirt Enters Hydraulic Systems

Potential trouble spots in machine control systems, as pointed out by Herbert Schmeil, project engineer, Hydraulic Equipment Co., Cleveland, Ohio.

Despite the extensive use of gaskets and seals in a modern hydraulic system, dirt still remains as the most common cause of circuit failure. Generally, dirt can enter the system during any one or all of three phases: (1) Design; (2) Manufacture; and (3) Operation and Maintenance.

Design Factors. If the oil reservoir is not designed with proper breathers, dirt can directly enter the tank—a common condition found on equipment used in the construction field. Also, if a breather is specified, it should be a design that requires only a minimum of servicing.

Filters are another potential contamination item. The oil type air filter is generally not satisfactory since operator failure to clean it will permit dirt to enter the system. Porous plugs are sometimes used for air filters, but are not suitable for very dusty conditions. In considering the need for filters on the reservoir, a design factor of importance is the rate of change in the volume of oil contained in the tank. For example, on the upward stroke of a single acting cylinder, oil is withdrawn from the tank at the same rate it is furnished to the cylinder. On the return stroke the flow conditions are exactly reversed. Thus, the highest rate at which the oil volume in the tank will change should be calculated to avoid undesirable air surges in and out of the tank, even if this maximum rate is of very short duration.

Pressure in the suction line is often a source of dirt entering the system. Many designers specify strainers in the oil tank requiring the oil to pass through the strainer on the way to the suction line. However, sufficient thought is not given to the pressure drop to avoid pressures below atmospheric in the suction side of the system. It is this condition which

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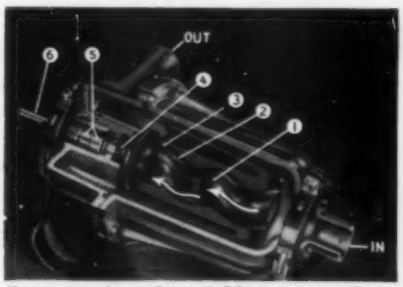

Cutaway view of small Moyno suitable for washers, drink dispensers, gasoline pumps and oil burners, circulating liquids, etc. As rotor (1) turns, cavities (2) move toward end of stator (3). Automatic shaft seal (4), precision ball bearings (5), drive shaft (6). May be designed to meet your problems.

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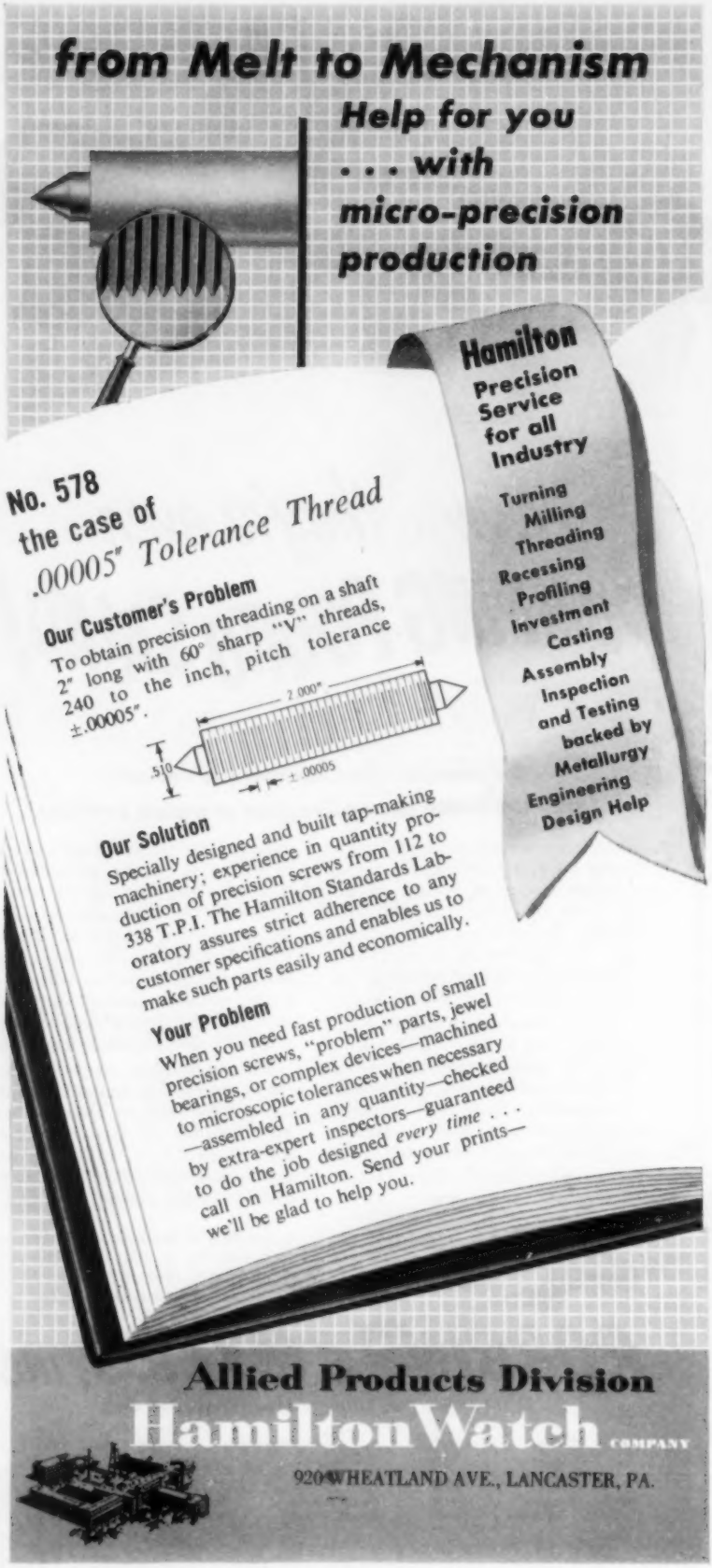
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adds to any mechanical defects in the suction line to allow dirt to enter. Recommended practice is to use partial filtering between the control valve and the hydraulically operated unit. But even if properly designed, this arrangement cannot prevent excessive amounts of grit from entering the system.

In many applications, wipers are not specified on a piston rod or improper wipers are designed. Under such conditions, grit and fine dirt can easily work their way through the cylinder packings and into the system. Since in many designs, oil pressure in the cylinder is always below atmospheric on one stroke, the packing end presents a potential trouble spot.

Boot seals are often recommended around piston rods as a cylinder sealer. However, since breather holes are necessary to permit collapsing of the boots, dirt can enter the cylinder and cause scoring of the rods. Changes in temperature often result in condensation of moisture inside the boots which can cause corrosion.

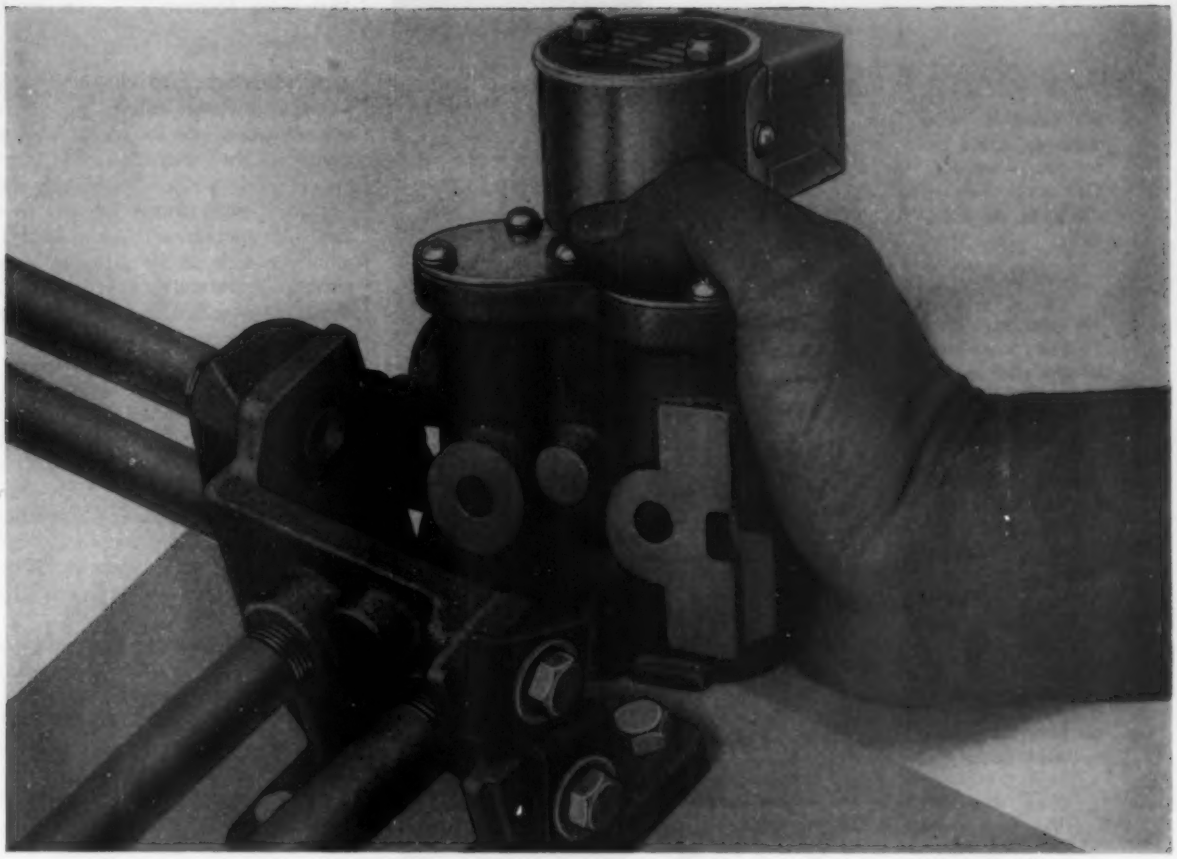
Because of the possibilities of piston rod scoring and corrosion, the use of chrome plating and electrolizing has become important. Comparing one to the other, electrolizing is denser and harder having a hardness between 80 and 87 R_c. Its thickness is approximately 1/10 that of chrome plating being only 0.0002 in. But despite the thinness of the coating, electrolizing has demonstrated better corrosion resistance on the basis of environmental tests.

The design of mounting plates for hydraulic valves is a point of caution to be observed. While a relatively simple precaution, often the plates are not thick enough to prevent warping when installed and tightened.

Manufacturing Factors. The correct coating for the interior of hydraulic tanks plus its proper application are very important. Use of AN specifications on the subject are helpful to select the coating for the fluid to be used.

Heat treatment of screw machine parts should be watched in the manufacture of hydraulic components. Unless the parts are thoroughly deburred and tumbled to free them from scale, fine pieces of scale will enter the hydraulic system and be a cause for pump or valve mis-operation.

Hose and pipe should be capped or plugged by the material supplier



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after manufacture to eliminate these items as probable sources of system contamination. At the manufacturing plant of the assembler, the pipes should be pickled, cleaned and plugged before storage or used in a particular application. Once assembled, any open ends of the pipes or hoses should be carefully sealed. Unless these practical but important factors receive proper consideration, considerable field trouble can be expected.

Operation and Maintenance Factors. Major damage to a hydraulic system is often a result of poor maintenance procedure. One element of this is the trouble caused by defective lubricating fittings. Recommended practice is to flush the fittings off with Diesel oil or gasoline under pressure. Wiping the fittings with a rag is generally not satisfactory.

Equally important is the potential trouble that can result from the disassembly of hydraulic systems for inspection and maintenance. Use of dirty work benches, not capping broken lines, and opened oil tanks are typical examples. But as with all other factors to be considered in keeping a hydraulic system free from dirt, the extra thought given to precautions will always pay off.

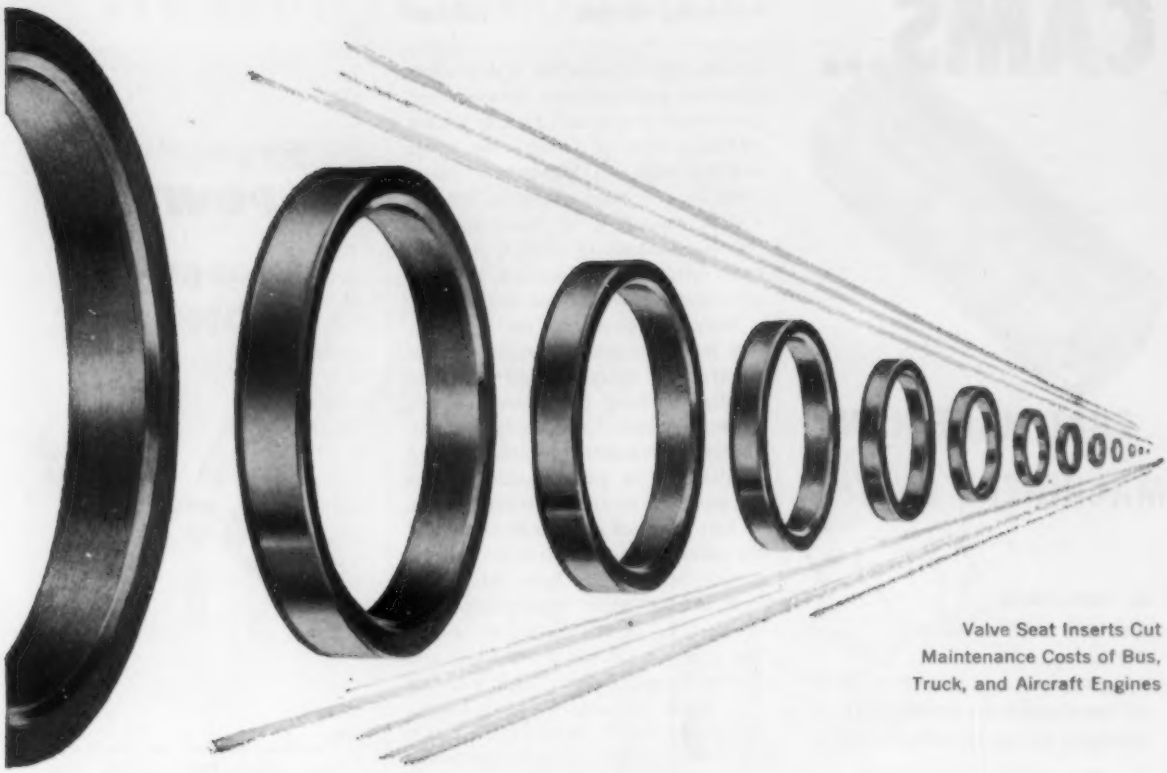
Components in High Production Machinery

Abstracted from "Requirements of Components in High Production Machinery," by R. W. Kowitz, Ford Motor Co., Dearborn, Michigan. Presented at 18th Annual Machine Tool Electrification Forum sponsored by the Westinghouse Electric Corp., Buffalo, N. Y., April 6 and 7, 1954.

IN THE DEVELOPMENT OF today's factories, machines have become larger, considerably more complicated, and correspondingly more expensive. Many are of the automatic type and have relieved man of much of the effort and fatigue formerly required to manufacture a product.

If the machine tool user is to realize the full potential of high production equipment, one important factor which must be kept in mind throughout the design and construction of the machine is reliability.

Consider, for example, the case of a transfer type machine which may cost as much as $150,000. In many cases,



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the entire production line is dependent upon one such machine. Should a single control device fail, such as a limit switch, a relay or a timer, the entire machine stops and production ceases. Thus, an item costing between $10 and $30 is responsible for losses amounting to thousands of dollars, resulting from interrupted production, and possible damage to machine components.

Since control devices are so important to the function of automatic and transfer type equipment, users are constantly searching for controls of the highest quality. Large equipment, involving high capital investments, must be designed to guard against failures traceable to seemingly trivial causes.

This does not necessarily imply that the control device which fails is always a poor one. It has been determined that, in some cases, misapplication of the device is the actual cause of failure. For instance, electrical switches and hydraulic valves have failed within a few weeks on some high production equipment, which cycled some 500,000 times per month. It was found that the devices were originally designed for aircraft purposes, with a normal life expectancy of only 100,000 cycles.

Reliability is also closely keyed to sound original designs, which anticipate future conditions. A particular detail may function properly when the machine is new, clean and well lubricated. But after a short period of time in production, it is not uncommon to find that a mixture of grease, oil and chips tends to impair normal mechanical movements.

This condition is often responsible for the malfunction of the operating components of limit switches. In some cases, it is necessary to resort to expedients, such as covering poorly located switches with a hinged chip deflector, and use the deflector as a secondary operating arm, in order to get along with the existing arrangements. It is essential that limit switches be located away from the region where chips and oil are apt to accumulate.

A similar problem exists on gravity operated fingers, or dogs, which engage the part during the transfer cycle. These fingers, while functioning properly when the machine is clean, often become stuck under the conditions previously mentioned. It is preferable that, under such circumstances, the transfer fingers operate positively.

Reliability should also be considered

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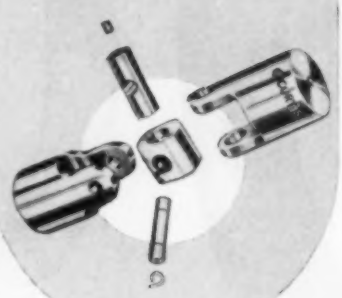

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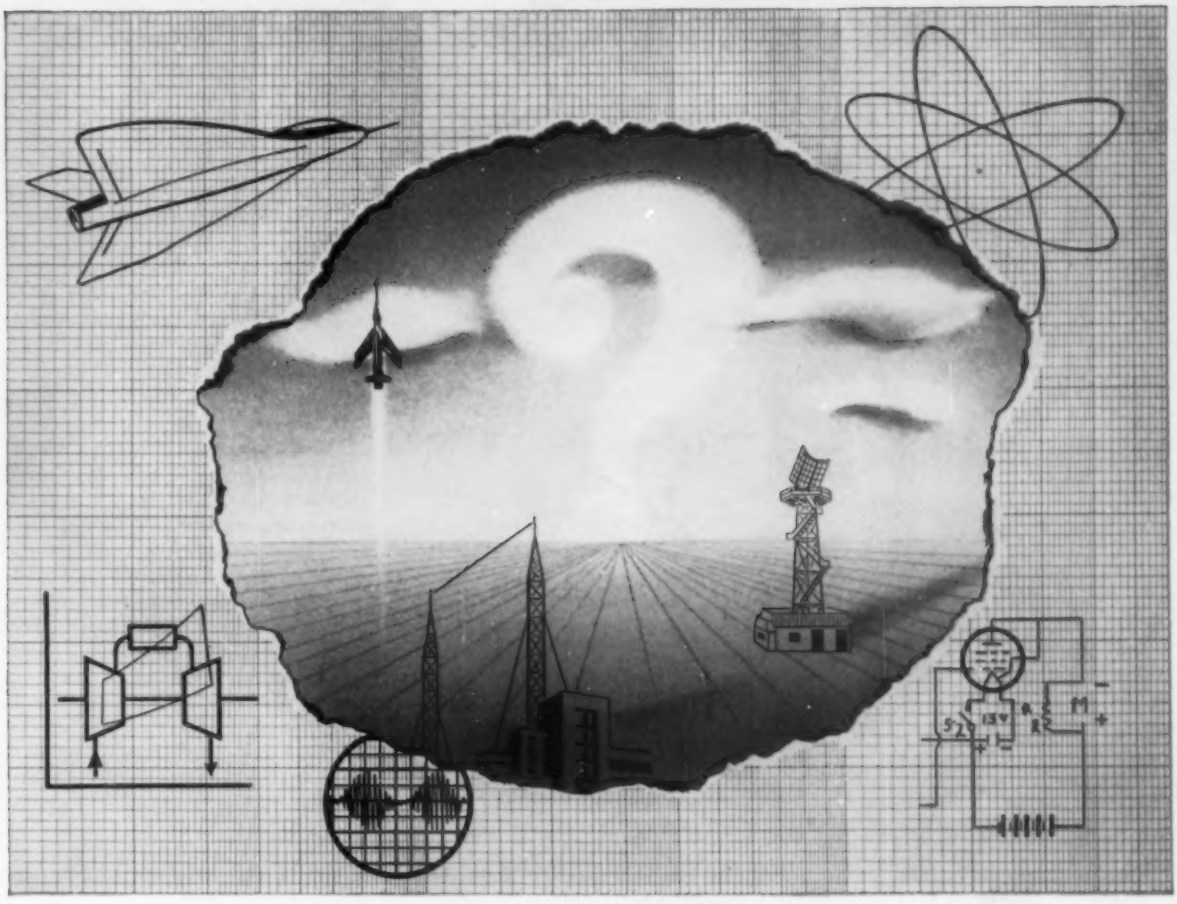

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when selecting the motivating means for operating automation or machine tool equipment. Should it be a simple mechanical unit driven by an electric motor, or a pneumatic unit, or a hydraulic unit? The advantages and disadvantages of each type of equipment must be carefully weighed. From the standpoint of maintenance and long life, the less complicated, the better.

Full consideration should be given to the construction of the components, and the operating conditions for each particular application. For instance, some types of electrically operated clutches are complex in construction, and are not sufficiently positive in action. If a pneumatic system is being considered, it should be remembered that an ample supply of clean, dry air is a major problem in almost every industrial plant. In the hydraulic field, in spite of improvements made to date in hydraulic equipment and seals, the common oil leak is a hazard to personnel, a major housekeeping problem, and a considerable expense where a large number of machines is involved. To avoid these inherent disadvantages, positive, mechanically operated units should be considered wherever applicable.

Still other failures are attributed to the use of control devices applied at ratings in excess of those listed by the manufacturer. Common examples are the bellows type pressure switches used on hydraulic systems operating above 50 psi. Surges far in excess of normal pressures occur frequently; these surges cause rupturing of the bellows. Piston type switches having a vent port should be used on such hydraulic applications. Switches of this type which operate on pressures as low as 50 psi were recently made available.

Automation and Maintenance Problems

Abstracted from "Electrical Maintenance in Automation," by R. N. Johnson, W. F. & John Barnes Co., Rockford, Ill. Presented as part of the panel on Automation at 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corp., Buffalo, N. Y., April 6 and 7, 1954.

WHEN MOST MACHINES were manually powered, the maintenance problem was entirely mechanical. When mechanically powered machinery came into use, maintenance personnel had to

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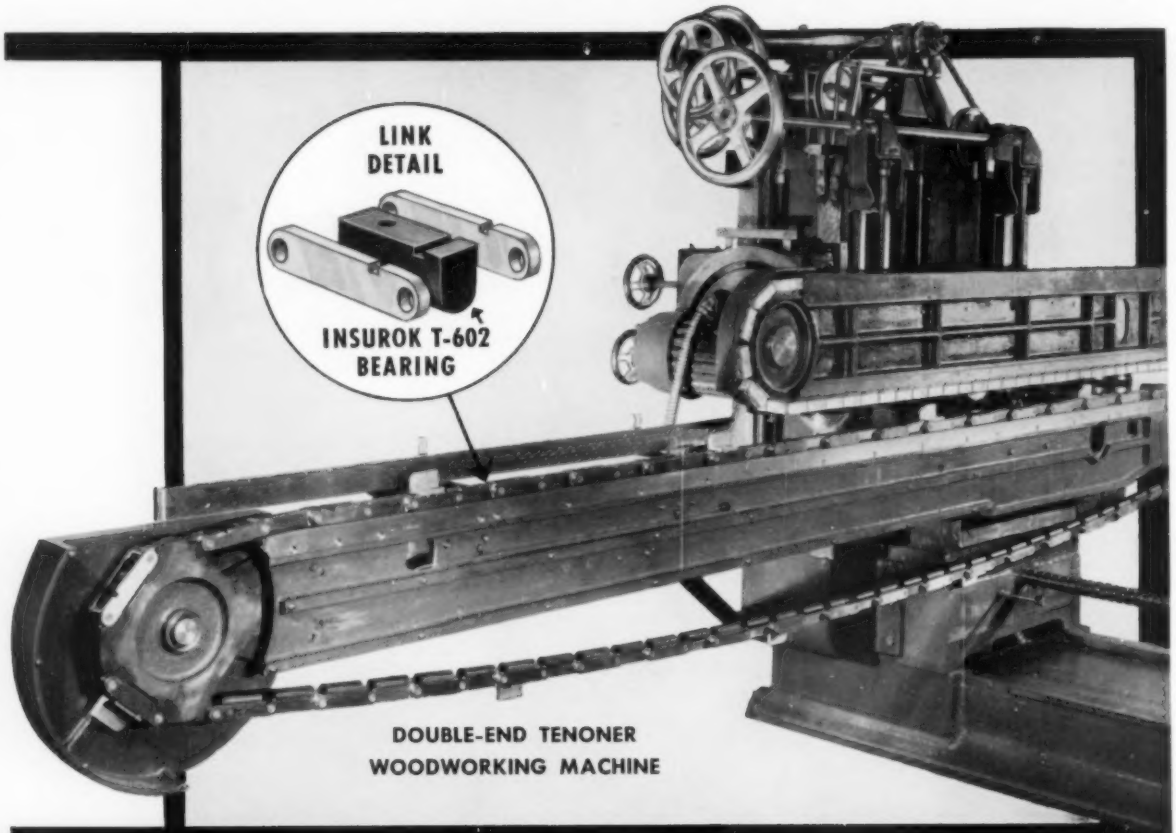

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Lubricating the chain and track on this woodworking machine was formerly a difficult problem. If enough oil were provided for proper lubrication, it would drip and stain the wood. On the other hand, if the oil supply were reduced, the ever-present sawdust, woodchips, and glue particles would cause excessive abrasion and wear—shortening chain life and reducing the accuracy of the machine.

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become familiar with the upkeep and installation of motors and their associated controls. These were relatively simple, and their maintenance accomplished without much difficulty. Machines then began to use hydraulic and pneumatic power as well as mechanical power. Limit switches, timers, relays and other less simple electrical equipment had to be used to control this new type of power, thereby complicating the maintenance problem. The condition, as it stands today, places maintenance personnel in a dominant position in a production plant. Yet, the emphasis in engineering and development of machinery has been predominantly on ease of operation and volume of production, with only secondary emphasis on maintenance.

If the production plant of tomorrow is to be a completely automatic plant, the development of the machinery that goes into that plant will of necessity be designed with maintenance as a predominant factor in that design. If this is not done, the unskilled or semiskilled personnel freed by the automation equipment will have to be replaced by an equal number of highly trained service technicians. To reduce the technical knowledge necessary for service personnel, conventional magnetically operated components should continue to be used wherever feasible.

To make their controls designers conscious of the need for consideration of maintenance in designing machines, W. F. and John Barnes Company are using a training program for these engineers. This program includes servicing of machines in the customer's plants and construction of machines on the Barnes assembly floor. This gives the design engineer an opportunity to observe the problems of maintenance that can be created by design which neglects it.

As machines become more complicated from a control point of view, more information about the control of that machine must be available to the customer's maintenance personnel. This information should be on paper, not verbal. It should be in the hands of the maintenance personnel, not in a file in the front office. This information should reach the various people concerned direct from the machine supplier, not from a central point in the customer's plant. It should be written in a form and language that can be readily understood. Compli-

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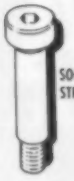

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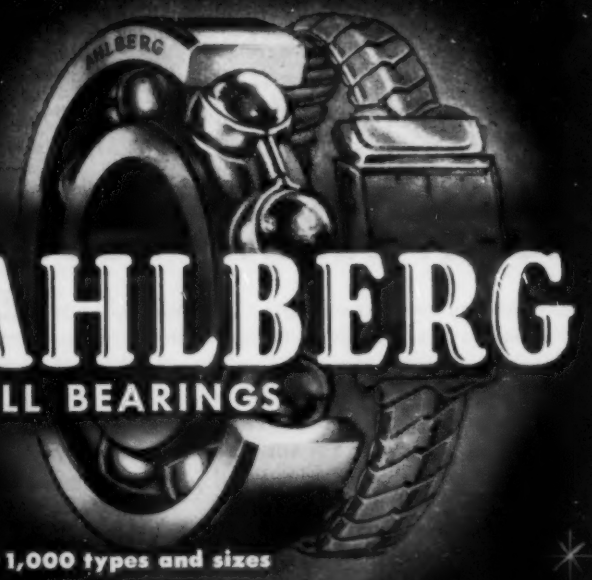

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cated multiline graphs presented in highly technical form, or long verbal descriptions using highly technical language, tend to tire the man who is trying to assimilate the information, and frequently causes the maintenance man to refuse to read all the information supplied. He then takes an antagonistic attitude toward the machine, and poor maintenance is the result. The Barnes Company recommends to customers that they encourage their maintenance and operating personnel to keep the control drawings for their machines. When they do this, it is a healthy sign that the maintenance personnel is interested in the operation of the machines.

Some of the methods that are being used to familiarize the customers' maintenance personnel with the operating principles of our machines are: Use of customers' maintenance personnel in installation of machines; and presentation of complete information on the controls of the machine. This information consists of:

(1) A schematic line drawing.

(2) A machine equipment layout.

(3) A complete equipment parts list and recommended maintenance parts list.

(4) A step-by-step description both in simple graphic form and in writing the mechanical sequence of operations of the machine.

(5) A step-by-step description in written form of the electrical sequence of operation of the machine.

(6) Assimilation of all above information into an eight and a half by eleven inch binder, which will withstand hard usage.

Some other methods are: personnel interviews between machine supplier engineers and customer production and maintenance engineers before and during design of the machine and after installation of the machine; and introduction of mechanical trouble finders on machinery to help maintenance personnel locate trouble with a minimum of down time.

The success of the completely automatic production plant of the future will depend largely on the attitude of the manufacturer of automatic machines toward the maintenance problems associated with those machines, and, conversely, on the attitude of the customers' maintenance personnel toward the machines which are produced with maintenance in mind.

NEW BOOKS

TIC Potentiometer Handbook

5½ x 8½ in., 207 pp. Published by Technology Instrument Corp., 531 Main St., Acton, Mass., $2.

This handbook is a detailed treatment of various phases of potentiometer theory, design, performance and application. The first three sections of this volume describe precision potentiometer terms and illustrate potentiometer component parts. Cutaway drawings are used liberally to show structural details.

Potentiometer performance characteristics, such as linearity, conformity, resolution, noise, power rating, frequency response, corrosive effects, mechanical acceleration and operating life are treated in Sections 4 through 7.

The design, construction and performance of both linear and nonlinear potentiometers are presented in detail in Sections 8, 9 and 10. Particular emphasis is given to the different methods for achieving precise nonlinear functions with potentiometers.

Section 11 deals with the methods for mounting and ganging potentiometers, and Section 12 describes such special potentiometer designs as multiturn, slide wire, translatory and differential potentiometers. The principle of operation of each of these types is clearly illustrated. Section 13 is a bibliography of the books, periodicals, papers, and specifications that comprise the principle literature in the field of precision potentiometers.

It is published in a loose-leaf binder which permits additional articles to be inserted as soon as they are issued. Full information on new potentiometers will be added periodically to this loose-leaf catalog to keep it up to date.

Coil Winding

WILLIAM QUERFURTH. *5½ x 8½ in., 125 pp. Published by the George Stevens Mfg. Co., Pulaski Rd. at Peterson, Chicago* 30, *Ill.,* $6.50.

This volume is an extensive treatment of the universal and progressive universal types of winding. Nomographic charts, never before available, aid in the determination of essential

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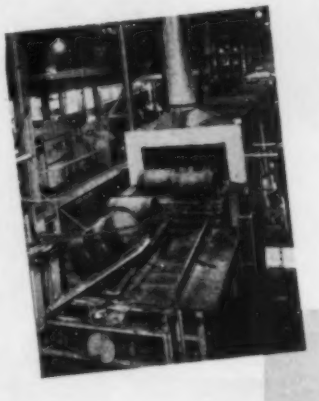

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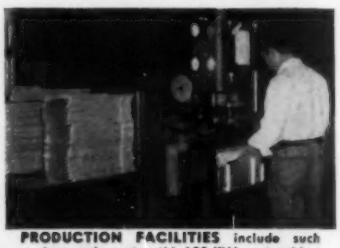

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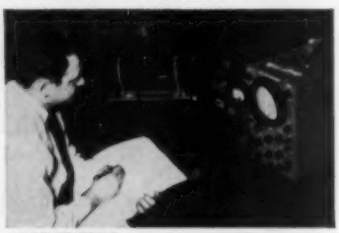

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gear ratios. Winding formulae and gear tables make this book equally valuable to experienced coil winding personnel.

Value to established coil winding firms is substantial. Detailed description of many processes and naming of all machine parts aid in the standardization of nomenclature in the industry. Instructions are given as to how to set up and align winding machines of various types, how to lay out a bench to best advantage for coil winding, how to make an arbor, a chuck, a collet, how to design cams, how to align wire guides, how to select and adjust various wire tension devices. Details are given on the proper process for inserting paper for multiple paper section winding.

Gear tables and gear formulae make the book valuable to any engineer. The tables include charts for cam driven machines and diagrams for equally important screw traverse machines as well as charts for universal winding machines. There is also an extensive table of reciprocals to aid in calculating gearing combinations for precise winding. Separate chapters cover single layer, multi-layer, universal type and progressive universal winding in great detail.

Essentials of Industrial Management

LAWRENCE L. BETHEL, *Director, New Haven College;* FRANKLIN S. ATWATER, *Asst. General Works Mgr., The Fafnir Bearing Co.;* GEORGE H. E. SMITH, *Lawyer and Economist; and* HARVEY A. STACKMAN, JR., *Pres., Executive Development Council.* 6 x 9 *in.*, 449 *pp. Published by the McGraw-Hill Book Co., Inc.,* 330 *West* 42*nd St., New York* 36, N. Y. $5.50.

Presenting an overall view of industrial management, this condensed, well-balanced, comprehensive new text emphasizes coordination as the goal of good management. This is achieved through effective human relations and communications and through the application of scientific principles in the planning and development of the various operations and segments of the enterprise.

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agerial problems. Thus, the book helps to develop a proper attitude toward industrial management as well as an aptitude for coping with the problems it presents. Because industrial management must be responsive to changes in economic and social conditions, new developments and changing emphasis, the authors review the latest trends in the field and stress industry's contributions to social gains.

Each chapter is divided into four main sections: presentation of basic questions and issues; presentation of basic principles; illustration of principles; and case studies for the practical application of the principles.

ASME Handbook—Metals Properties

Edited by SAMUEL HOYT, *Metallurgical Consultant, formerly Technical Advisor, Battelle Memorial Institute.* 7½ x 10 *in.*, 433 *pp.* ***Published by McGraw-Hill Book Co., Inc.,*** 330 *West* 42 *St., New York* 36, *N. Y.* $11.

This Handbook is the direct outgrowth of a survey conducted in 1941 by the Metals Engineering Division. Disclosure that a need for it existed was somewhat startling because of the many reference books already available, and the excellent coverage of some of them. The survey explained, however, that other references were not written for the design engineer nor exclusively from his viewpoint, and that the existing handbooks did not contain the scope of metals engineering information needed by the design engineer. In practice he looked through many references to find related information on a single material, if, indeed, that information were available at all. This Handbook has been written to satisfy that need, to compile in one place engineering data on metallurgical, physical, fabrication and mechanical properties of typical metals.

The design engineer is accustomed to using specification values of the properties with which he is concerned, since it is on such values that the engineer purchases material and supplies a product, usually under contract. For these, he should refer to the applicable specification, because they would want to use the one that is currently in effect.

Specifications by no means give all the data on a material that the engi-

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neer needs. It has therefore been the aim of the present volume to furnish comprehensive data with comments necessary to characterize the material and typify its uses for the guidance of the designer.

The data presented are organized according to the following plan:

1. Metals of like kind are grouped together. An ascending numerical sequence of designation is followed, with occasional exceptions necessitated by publication limitations.

2. All data for each metal are reproduced under the designation for that metal.

3. Metals have been identified, in most instances, by the designation commonly used by the fabricating industries. A cross index is provided for further identification by other systems.

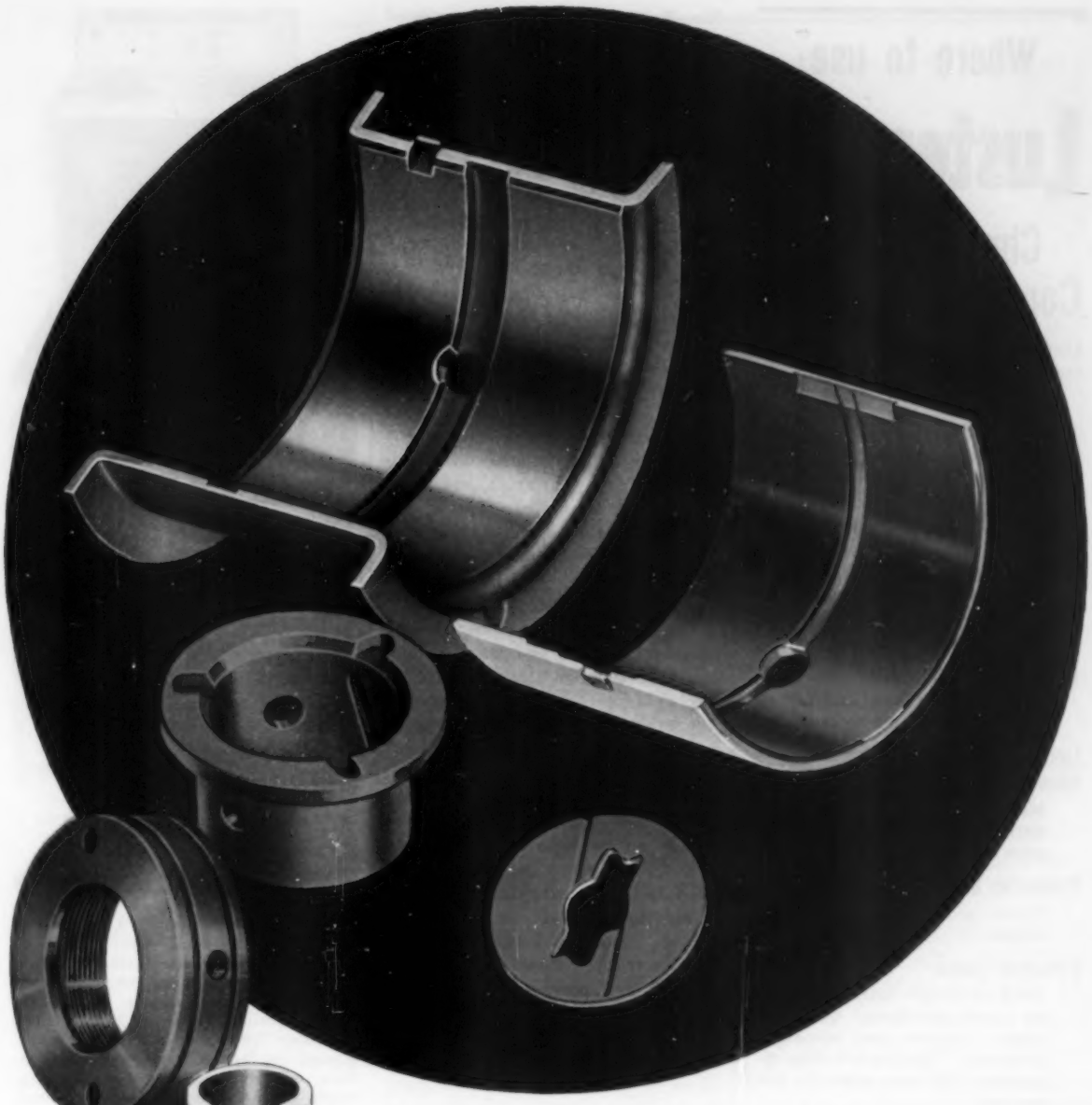
4. A skeleton format has been employed to obtain continuity in presentation.

5. Properties reported cover sizes, forms, and conditions (cold work, heat-treatments, etc.) in which the metal is usually used. This has resulted in omissions from the skeleton format where specific data were not of importance to the typical applications for the metal.

6. The English system of units has been employed except where metric units are conventional, or where conversion would bias interpretation of data from the published source.

This plan was adopted with the hope that it would (1) facilitate reference, (2) aid the user to write in new information of special interest as it becomes available, and (3) give research groups and suppliers some indication of omissions in available data.

The data presented in this Handbook come in one or the other of two categories. They are either average values representative of good practice or actual test values on single individual specimens. A typical case of reporting average values is that of the "physical property charts" of the SAE steels. They give what is expected, on the average, for the middle of the range of composition. They offer a good compromise, since a producer will not care to cite minimum values that would stamp his steels as of inferior quality; and he will not care to cite the very best values, for, in that case, the user would experience too many cases of failing to get the published values. With this as a guide, the engineer



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should be able to determine the properties he can rely upon and the metallurgist should be able to decide on compositions and treatments to produce those properties.

Information on the various physical properties of the pure metals are relatively accurate in determination and simple to use. Reasonably high purity of the test samples is usually guaranteed; and most investigators know that the metal must be soft-annealed to avoid vitiating the determinations by extraneous effects of cold work and its accompanying structural characteristics. While physical measurements always involve an "error," or uncertainty, the results are usually quite accurate with respect to purity, structure, and measurement. Within the experimental error there is little likelihood that most of the data are far wrong, and accordingly, there is little likelihood of making improper use of such data.

The many mechanical properties of commercial metals and alloys require somewhat different treatment and interpretation. These are the data subject to the significant variations as described previously. Data for the heat-treating steels call for special comment. Until recently the carbon and alloy steels (SAE steels) have been treated largely on an individual basis, and indeed, they do have individual characteristics. But it is now clear that steels, almost regardless of composition and alloying elements, have surprisingly uniform tensile properties at the same hardness level, provided they are "fully hardened" when quenched.

The magnitude of the effect of producing an incompletely hardened condition by quenching is due principally to the "mass effect," and is shown by data on the mass effect of certain steels that appear in many of the tables of properties on wrought steels. This effect is also brought out by the inclusion of end-quench hardenability test data. Such data show the relative depths to which various carbon and alloy steels harden and at about what depths the incompletely hardened structures begin. They also show that little or no alloy is needed to harden small sections to produce optimum properties, but as the section size increases, the need for "hardening" elements increases to produce similar results. These generalizations were developed at a recent date but have been found to be a guide for the selection

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of steel compositions and treatments. Now that this information is available, it should be applied when using or interpreting data on the properties of heat-treated steels, at least for the ordinary tensile properties.

For data covering properties other than the simple static and tensile properties, the situation changes for all types of metals and alloys. This group includes such properties as notch toughness, notch fatigue, impact behavior or high-velocity loadings, fatigue, corrosion fatigue, low-temperature properties, high-temperature properties, corrosion, magnetic properties and damping.

Facts About Stampings

Pressed Metal Institute. 5½ x 8½ in. Paper Bound. 32 pp. Published by the Pressed Metal Institute, Department FPR, 2860 East 130 St., Cleveland 20, Ohio. $.50.

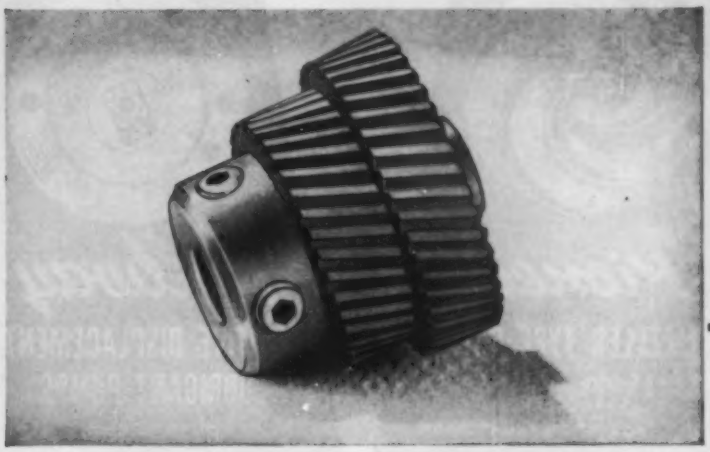
This book is offered as an aid to those who are faced with problems in the designing and redesigning of parts for metal stamping products. Fundamentally, stampings offer production economy and material conservation. The book is designed to show how these have been attained with metal stampings.

Included in the subjects covered are: Holes; Flanges; Flanges and Radii; Layout; Notches and Slots; Gage Inspection; Tolerances; Steel Gages; Dimensions; Checklist for Prints; Press Section; Definitions; and Suggested Terms and Conditions of Sale for the Industry.

Magnetic Fields of Cylindrical Coils And Annular Coils

CHESTER SNOW, *National Bureau of Standards Applied Mathematics Series 38. 8 x 10 in., Paper Bound, 29 pp. Order from Government Printing Office, Washington 25, D. C.,* $.25.

In the past many formulas have been published which give effect of the magnetic field as either the inductance of such a coil or the force between two such coils when a known current exists in them. In contrast with this, the present publication gives a basis for computing in full detail the magnetic



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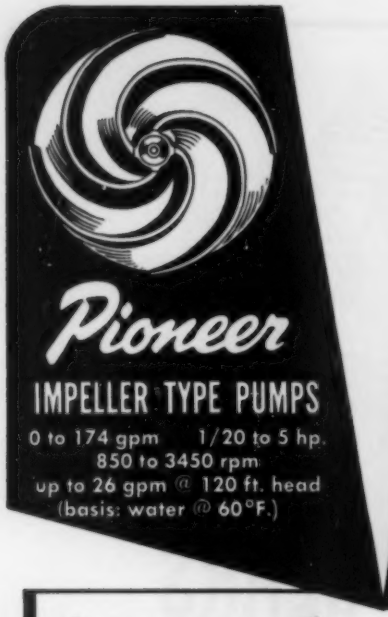

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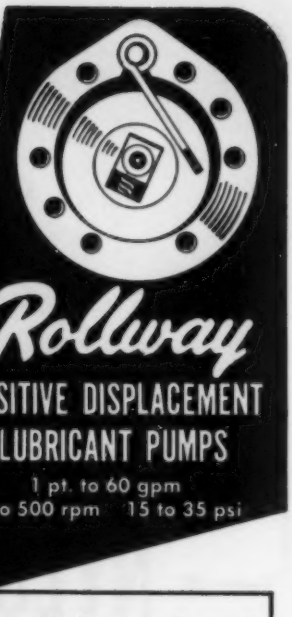

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field itself, point by point. No formulas for this purpose have been readily available hitherto.

The publication gives the axial and radial components of the magnetic field at any point in space of a cylindrical or an annular coil carrying an electric current. The results are expressed in terms of complete elliptic integrals or of Legendre functions which involve ratios of the significant dimensions of the coils.

In experimental work it is frequently necessary to produce an accurately known magnetic field, and the use of one or more solenoidal coils of measurable dimensions is usually the most convenient way of accomplishing this. Possible applications range from the laying-out of large current-limiting reactors in electric power stations to the design of coils for studying paramagnetic resonance in atomic nuclei.

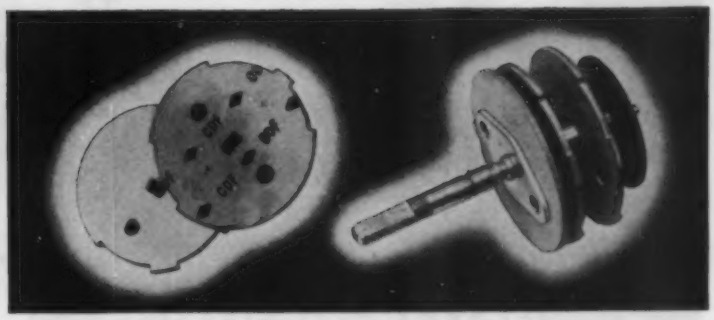
Elements of Structural Engineering

ERNEST C. HARRIS, *Professor and Chairman, Dept. of Civil Engrg. and Engrg. Mechanics, Fenn College.* 6 x 9 *in.*, 505 *pp. Published by The Ronald Press Co.*, 15*East* 25*th St., New York* 10, *N. Y.*, $7.

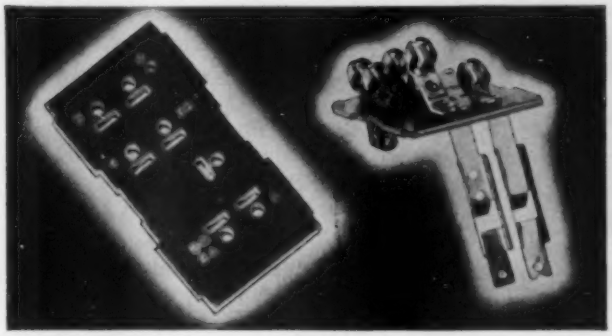
This is a text in structural engineering for the non-civil engineering student. The material is presented, wherever possible, from his point of view. The principles are presented, then their application is shown by examples and problems that are largely of the type commonly met by mechanical, electrical, and other non-civil engineers. Thus, examples of bridges are omitted, while examples of structural theory applied to such things as cranes and conveyor supports are included. The complete original design of buildings is omitted, but the same principles are used in examples in which the effect of new electrical or mechanical equipment on the safety of existing structures is analyzed.

Some of the illustrative examples and problems are given in basic form. Others are presented as they are encountered in practice, so that the student is given a chance to determine the loads and to reduce the problem to its basic form before solving. The problems are of two kinds: shorter ones suitable for homework assign-

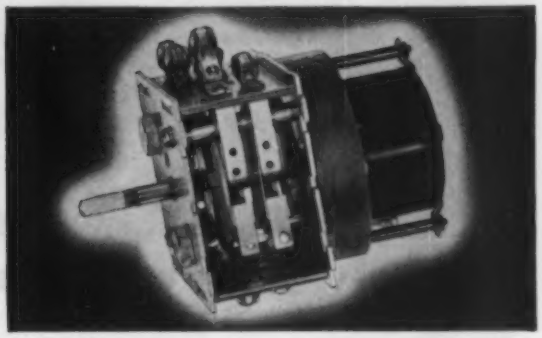
What makes the miracle of automatic washdays? What gadget turns water on and off; starts spinners, agitators, fans; regulates heat . . . all on a precise timing schedule? Chances are it's a P. R. Mallory timer switch.



Special paper-base Dilecto laminated phenolic cams are the heart of the switch. If the corners are not sharp, if tolerances are not held, if the laminated plastic fails, the timing schedule would go haywire. But it doesn't happen with Dilecto cams *fabricated by C-D-F*, now definitely identified for performance comparison.



C-D-F also supplies these Dilecto insulating side boards. Dilecto Grade X-13 was chosen for its ability to withstand severe riveting and staking impact, for its sturdiness in holding up under the strain of plugs being inserted and removed from terminals mounted on the board.



Look inside the smart, small, tough Mallory timer switch. The shaft revolves; with the switch operated by a manual clock which is wound or set whenever the switch is turned over to complete the entire cycle. *Switch accuracy depends entirely on the degree of accuracy in which the cam is manufactured.*

C-D-F and DILECTO® LAMINATED PLASTIC helped Mallory

improve design . . . simplify purchasing . . . speed production

Two C-D-F Dilecto laminated plastic parts play small but vital roles inside P. R. Mallory's timer switches used to control the washing, drying, rinsing cycles.

Most important, the timing cams must be precisely fabricated to odd, notched shapes, with very close dimensional tolerances. In the design stage, it was first thought that there was no practical way to obtain the desired pieces.

But engineering-supplier teamwork always pays off. Good basic design . . . a quality material from an alert, interested fabricator . . . selective purchasing resulted in a solution.

C-D-F WORKS WITH DESIGNERS

A father and son team, in Mallory's Switch Division, Arthur and Harry Hall, began 15 years ago to make this timer switch. Cam material after material was tested . . . none worked satisfactorily.

C-D-F sales engineer Robert Tappan was called in. He says, "After 18 months, the design was adaptable to Dilecto laminated plastic. The first cam did not work, but showed promise. Looking back, it was a crude punching compared to the ones now furnished by the C-D-F Valparaiso plant."

A BIG, RELIABLE SOURCE

Mallory makes thousands of timer switches, naturally has several suppliers for laminated plastic insulation. But C-D-F keeps working hard to further improve the product: Special tools have been designed to increase the accuracy of C-D-F cams, to provide Mallory with *lower rejection* rates. Resin-penetrating and laminating techniques have improved Dilecto grades. Inspection and quality control have been modernized.

When you have a problem in laminated plastics, think of improved, Dilecto and C-D-F. Send us your print for technical advice and quotation. Write for free test samples. The C-D-F catalog is in Sweet's Design File and the IRE Directory. Best of all, call your C-D-F sales engineer . . . He's a good man to know!

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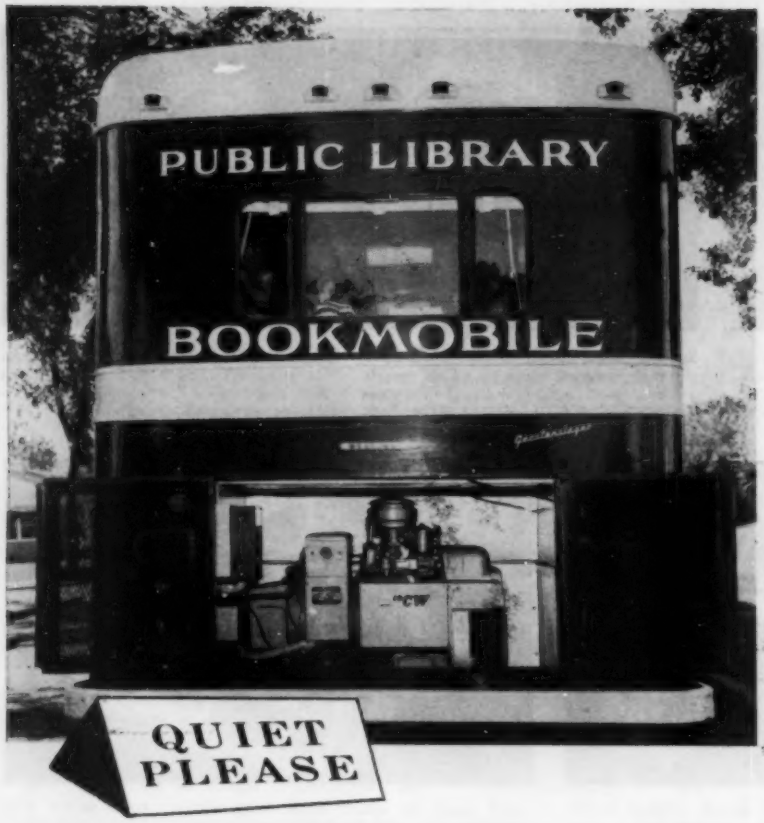


In mobile installations like this . . .

ONAN Electric Plants *eliminate noise and other major problems*

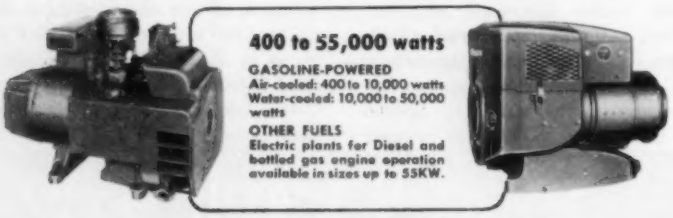
This traveling library in Minneapolis is completely electrified with lights, many motors and even electric radiant heating. The electrical load demanded a 10,000-watt generating plant . . . much more capacity than is required in most mobile installations. This size plant would normally intensify problems of noise, weight, space, vibration and possibly cooling.

Working with library authorities and the Gerstenslager Company, builders of the mobile unit, Onan engineers solved these problems with an Onan "CW" electric plant of 10,000-watt capacity.

The Onan model 10CW is vacuum-air-cooled, that is, the cooling air is *drawn* through the generator and out over the cylinders. The effect is a muffling of all engine, generator and fan noises to a point where, in this installation, it is difficult to tell when the electric plant is running.

Space required by the 10CW is about half that of an ordinary water-cooled electric plant (generally considered where noise is a factor) and the weight is less than half. The two-cylinder gasoline engine is inherently smooth running and only a few inches of ducting are required for exhausting heated air.

The many built-in advantages of Onan Electric Plants will solve similar design problems for you. Let us know your requirements.



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ments and for classroom use, and longer ones suitable for supervised problem sessions. This book includes tables of section properties, load data and other standards.

Chapter headings include: Equilibrium and Reactions; Shears, Thrust and Bending Moment; Analysis of Trusses and Bracing; Analysis with Moving Loads; Deflections in Beams; Design in Steel—Members; Design in Steel—Connections; Design in Concrete; and Design in Timber.

Residual Stresses in Metals and Metal Construction

Edited by W. R. Osgood, *Professor of Mechanics and Chairman of the Department, Illinois Institute of Technology. 6 x 9 in., 363 pp. Published by the Reinhold Publishing Corp., 330 West 42 St., New York 36, N. Y., $10.*

Prepared under the guidance of the Committee on Residual Stresses of the National Academy of Sciences—National Research Council, this monograph describes and carefully evaluates the effects of residual stresses upon the performance of various kinds of structures. Particular emphasis is placed on the possible contributions of these stresses to fracture.

Twenty-two papers, contributed by specialists in the field from both here and abroad, offer a wide range of information on the origin, magnitude and distribution of all types of residual stresses existing in a structure or a machine, whether arising from welding, machining, or other causes. In addition, a special summary prepared by the Committee covers many aspects of the residual stress problem, and includes several recommendations for future research and study.

Chapter headings include: Effects of Residual Stresses on the Behavior of Structures; Residual Stresses in Welded Pressure-Vessel Manufacture; Residual Stresses in Welding; The Significance of Residual Stresses; The Influence of Residual Stresses on the Behavior of Ductile Structures; Influence of Residual Stresses on the Brittle, Plastic and Fatigue Behavior of Structures; Shakedown of Elastic-Plastic Structures; The Effect of Residual Stresses on High-Speed Impact Resistance; Correlation of Residual Stresses with Fatigue Strength of Machine Elements and Related Phenomena.

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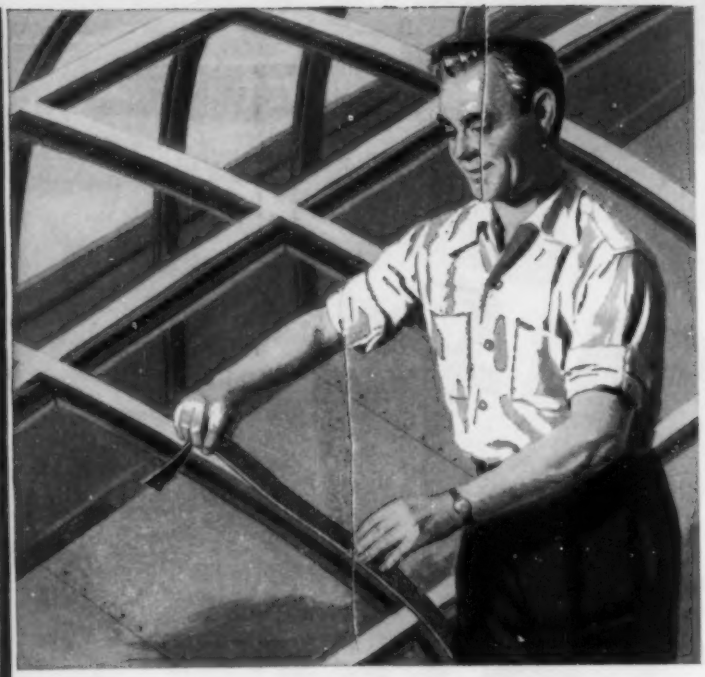

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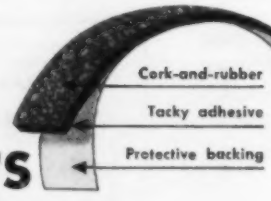
This unique material is also used as an anti-skid pad on small appliances to prevent sliding on polished desks and tables. It doubles as a cushion and seal in glass-to-metal joints in parking meters and vending machines. It also is used to protect fragile parts from breakage and scratching during shipment.

DK-153 carries its own adhesive. To apply it, you just peel off the cloth backing and press the tape into place.

You can get Armstrong's DK-153 Tape in sheets, rolls, ribbons, or die-cut shapes, and in a wide variety of widths and thicknesses. For samples, write on letterhead to Armstrong Cork Company, Industrial Division, 7307 Irvin Street, Lancaster, Penna. Available for export.



ARMSTRONG'S
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OUR READERS SAY

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Dispelling the Fog

To the Editor:

You will be interested in learning that your May editorial "Horns Blowing in the Fog," was devoured with considerable interest. In fact, I read most of it before a group of senior high school students in a talk before them in an effort to arouse interest in the study of engineering.

Since you did not mention the National magazine, I wonder which you are referring to. How about electing you to write a countering article?

—Oscar J. Horger
The Timken Roller Bearing Co.

Ed—We are interested in learning that the editorial "Horns Blowing in the Fog" was "devoured with considerable interest."

One good turn deserves another. Therefore, we would like to clear up the question concerning the magazine. The article was published originally in *Collier's* and was digested in the *Reader's Digest*. For your information, both *Collier's* and the *Reader's Digest* have been sent a copy of the editorial. We are interested in seeing what form their replies will take.

Solving Gearing Equations

To the Editor:

Mr. Sigmund Rappaport's paper "Whole Number Solutions of Indeterminate Equations for Gearing" which appears in the May 1954 issue of *Product Engineering* describes the use of diophantine equations to find integral solutions of linear equations. This method is undoubtedly practical for equations encountered in working with gears. The use of continued fractions which, like diophantine equations, are considerably old, is better suited for problems where larger coefficients are the rule. Consider, for

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Because they're *all stainless* — their strength-weight ratio is higher than you'd find in low alloy carbon steel. The cars are *lighter yet stronger* than ordinary steel cars, which means the Santa Fe will be able to haul as many as 25 of these cars with the same drawbar pull they'd need for 20 low alloy carbon steel cars.

What's more, the passive surface of Crucible stainless will never need painting . . . never need more than a "once-over-lightly" by maintenance crews to keep its sparkling new look. And, beneath the skin, where corrosion and vibration can undermine the strength of vital structural members — the high corrosion resistance and fatigue strength of Crucible stainless will keep these cars in service for a lifetime.

Budd would not have chosen stainless for all the cars they build unless it was a *practical shop metal.* And it is. For it can be formed, machined, welded, drawn, heat-treated — processed in any way you'd normally use for ordinary steel.

So don't forget the Crucible family of stainless steels where you need corrosion resistance . . . high fatigue, creep and structural strength . . . resistance to wear and temperature extremes . . . workability. We'll be glad to help you select the best stainless grade for your job. Let our Metallurgical Engineering Department make practical suggestions.

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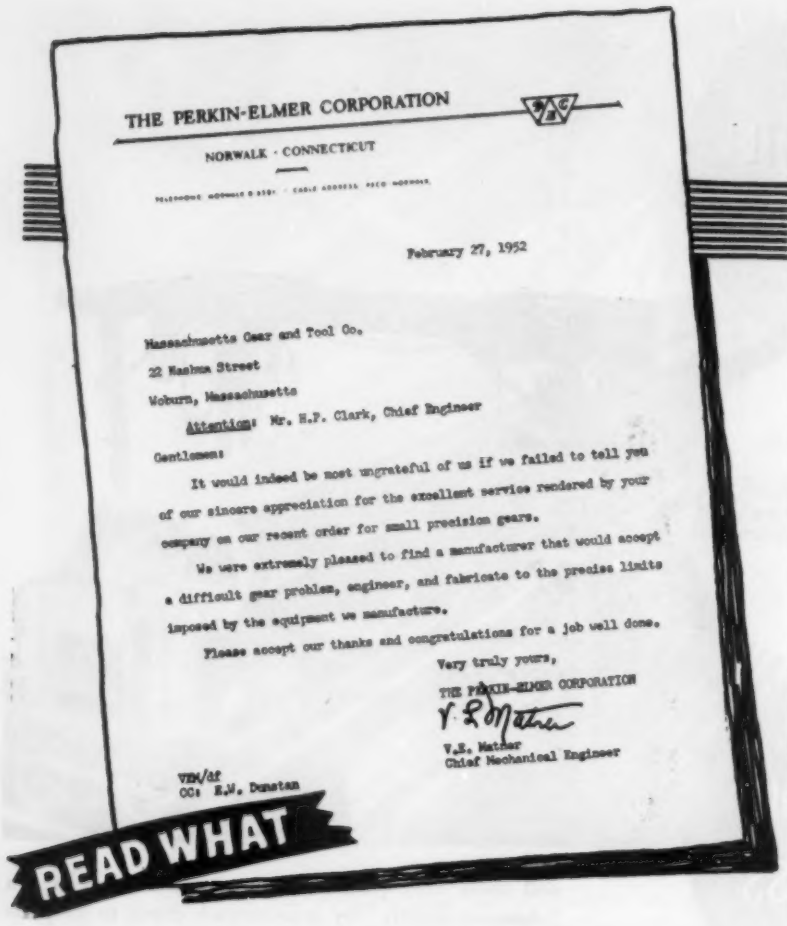
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Please accept our thanks and congratulations for a job well done.
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example, the well-known monkey and cocoanut problem which involves finding integral solutions for the equation

$$1024x - 15625y = 8404.$$

The coefficients of x and y can be combined to form a continued fraction:

$$\frac{15625}{1024} = 15 + \frac{265}{1024} = 15 + \frac{1}{3 + \frac{229}{265}}$$

$$= 15 + \cfrac{1}{3+\cfrac{1}{1+\cfrac{1}{6+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{3+\cfrac{1}{3}}}}}}}$$

If the final fraction, $\frac{1}{3}$, is dropped and the process of forming the fraction reversed, the following results:

$$15 + \cfrac{1}{3+\cfrac{1}{1+\cfrac{1}{6+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{3}}}}}}$$

$$= 15 + \cfrac{1}{3+\cfrac{1}{1+\cfrac{1}{6+\cfrac{4}{11}}}}$$

$$= 15 + \cfrac{1}{3+\cfrac{1}{1+\cfrac{11}{70}}} = \frac{4776}{313}$$

These numbers, 4776 and 313, are such that if the larger is multiplied by the smaller of the original coefficients, and the smaller by the larger of the original coefficients, the difference between the resulting products is unity. This is a basic property of continued fractions.

In the problem under consideration,

$$1024 \times 4776 = 4840\,624$$
$$15625 \times 313 = 4840\,625$$

so that

$$1024 \times 4776 - 15625 \times 313 = -1$$

and

$$1024[(4776)(-8404)] - 15625[(313)(-8404)] = 8484$$

Therefore

$$x = 4776 - 8404 = 40,137,504$$
$$y = 313 - 8404 = 2,630,452$$

is a solution of the original equation. It is evident, then, that all possible solutions must be of the form

$$x = -40{,}137{,}504 + 15625n$$
$$y = -\ 2{,}630{,}452 + \ 1024n$$

and it is quickly established that the smallest positive value of x is 3121.

This method of solution is somewhat involved; however, Mr. Rappaport's method would be even more involved, since it would require the introduction of new quantities.

Before attempting the solution of such an equation, it is often advisable to establish whether or not a solution is possible. If the equation is:

$$Ax + By = C$$

and if k is the largest factor common to A and B, then it follows that

$$A = A'k$$
$$B = B'k$$

where A' and B' are integers. Therefore

$$A'kx + B'ky = C$$

and

$$A'x + B'y = \frac{C}{k}$$

Now, if C is not divisible by k, no solution is possible, since the left-hand side is an integer for all integral values of x and y, while the right-hand side is a non-integer. If, however, C is divisible by k, there develops

$$C = C'k$$

where C' is an integer. The original equation can be reduced to the form

$$A'x + B'y = C'$$

This equation can then be solved by the method of continued fraction.

There still remains the problem of determining the largest factor common to two integers. If A represents the larger number and B the smaller, then

$$\frac{A}{B} = C + \frac{D}{B}$$

where D is an integer smaller than B. If k again represents the largest factor common to A and B, then

$$\frac{A'k}{B'k} = C + \frac{D}{B'k} = \frac{CB'k + D}{B'k}$$

Therefore,

$$A'k = CB'k + D$$

and

$$D = k(A' - CB')$$

proving that the largest factor common to A and B is also common to D. Now if r is the largest factor common to D and B, it develops that

$$\frac{A}{B''r} = C + \frac{D''r}{B''r} = \frac{CB''r + D''r}{B''r}$$

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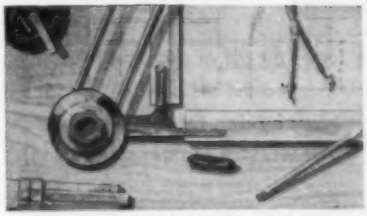

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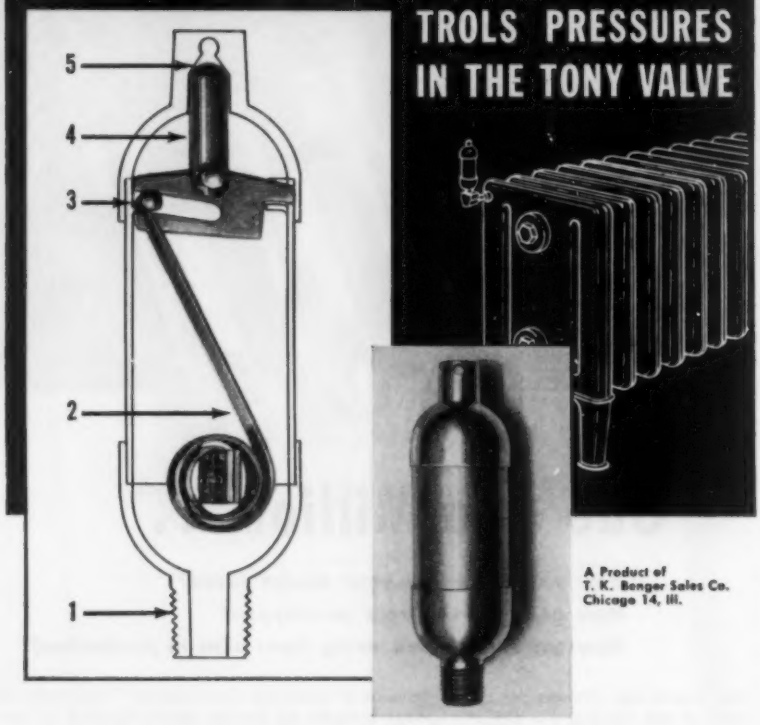

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T. K. Benger Sales Co.
Chicago 14, Ill.

One of the age-old problems of releasing trapped cold air from steam radiators has been solved in the Tony Valve by the use of Thermostatic Control rather than by relying on pressure to actuate the venting mechanism. By using a coil of Chace Thermostatic Bimetal, the vent remains open until the heated steam travels the full length of the radiator and only then closes, after all of the trapped cold air has escaped.

In operation, the pressure of steam forces air out of radiator, into Tony Valve at fitting (1), through body of valve and out at (5). After cold air is completely exhausted and heat enters body of valve, thermostatic bimetal element (2) bends, moving pin (3) to left in slot in arm of plunger assembly (4). As left end of arm is locked in body, plunger is forced down into seat at (5) closing vent and sealing radiator and valve against further release of pressure.

This simple, positive and trouble-free unit releases pressure only when cold and closes only when warm to eliminate the old problems of pressure operated valves. All parts of the Tony Valve are of brass except the bimetal element.

This is but one of the many uses of Chace Thermostatic Bimetal in controls and recording apparatus. If you are interested in temperature responsive devices, read "Successful Applications of Chace Thermostatic Bimetal". Write today for this 36-page booklet which contains applications and 10 pages of engineering data on thermostatic bimetal.

W. M. CHACE CO.
Thermostatic Bimetal
1507 BEARD AVE., DETROIT 9, MICH.

and

$$A = r\,CB^n + D^n$$

so that the largest factor common to D and B is also common to A. The largest factor common to A and B, therefore, is also the largest factor common to D and B.

Similarly developed is:

$$\frac{B}{D} = E + \frac{F}{D}$$

$$\frac{D}{F} = G + \frac{H}{F}$$

$$\frac{F}{H} = J + \frac{K}{H}$$

where the largest factor common to K and H is also the largest factor common to the original numbers, A and B. If this process is continued:

$$\frac{P}{Q} = R + \frac{S}{Q}$$

$$\frac{Q}{S} = T$$

The largest factor common to S and Q is also the largest factor common to A and B, and S is obviously the largest factor common to S and Q. Therefore it is also the largest factor common to A and B.

It is apparent that the above process is identical with that required to set up a continued fraction, and, in fact,

$$\frac{A}{B} = C + \cfrac{1}{E + \cfrac{1}{G + \cfrac{1}{J + \cfrac{1}{R + \cfrac{1}{T}}}}}$$

Thus, the determination of the solvability of the equation and the solution can be carried out simultaneously.

CHARLES C. FOSTER

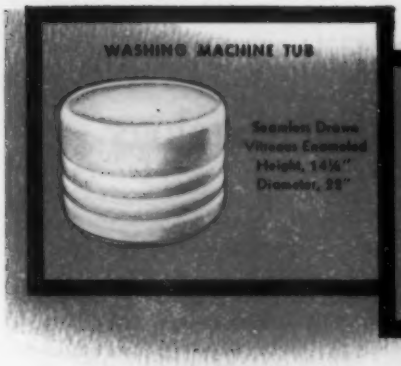
Incomplete Drawings—Complete Confusion

To the Editor:

This note is just to commend Dean Gerardi for writing "Should Current Drafting Practice be Further Simplified," *Product Engineering*, May 1954.

He certainly has presented the real facts, and sensible people will recognize and accept them as words of wisdom. As University of Detroit freshmen say "Complete drawings will avoid complete confusion."

—GEORGE E. ROWBOTHAM
Chandler-Evans



IT'S OUR BUSINESS
TO MAKE STAMPINGS LIKE THESE FOR YOUR BUSINESS

G.P.&F.

...MEETS YOUR NEEDS FOR LARGE AND MEDIUM SIZED SEAMLESS STAMPINGS *plus* COMPLETE FINISHING AND ASSEMBLY FACILITIES

● If you use seamless drawn stampings—whether it's for ammunition boxes or washing machines—G. P. & F. can fill your requirements, *economically*. What's more, G. P. & F. meets the most rigid delivery schedules with parts that pass strictest quality tests!

G. P. & F. specializes in large and medium sized seamless drawn stampings. And we have complete facilities for finishing and assembling ... galvanizing, spray finishing, vitreous enameling, welding. Over 74 years' experience ... 1000 skilled people ... 293 deep draw and stamping presses ... 97 welding machines. And a complete tool and die department. What's more, we can package your products and ship directly to your customers.

So, if you need deep drawn or stamped metal parts for your products, call on G. P. & F. We'll give you complete information, and help solve your production problems.

Write today for copy of booklet—"Science and Skill in Sheet Metals." It illustrates many jobs produced for Geuder, Paeschke & Frey customers ... gives complete data on our facilities.

G.P.&F. CONTRACT DIVISION MILWAUKEE

GEUDER, PAESCHKE & FREY CO.
1505 W. St. Paul Avenue, Milwaukee 1, Wisconsin

Photo courtesy American Sterilizer Co., Erie, Pa.

"Just What the Doctor Ordered"

New Super-Soft Rubber Pads Developed for Surgical Table Headrest

This surgical patient's head is in firm but gentle hands. The tight grip of the surgical table headrest shown above is now cushioned by super-soft (20 durometer) solid rubber pads. These pads are almost as soft as sponge but can be decontaminated and sterilized far more easily. Being made of neoprene, they are unaffected by oils, acids or decontaminating and sterilizing solutions. Furthermore, repeated sterilizing in live steam does not cause excessive hardening.

The neoprene compound specially developed for this purpose is 10 to 15 durometer points softer than normal commercial limits. For that reason, special care and skill must be taken in mixing and molding.

The successful development of this special purpose rubber part typifies the complete engineering and laboratory—as well as manufacturing—service offered by Continental.

Why not let Continental engineers consult with you in the planning or blueprint stage? Their specialized skill might help you get better rubber parts for your requirements.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these standard parts are shown in Continental's No. 100 Engineering Catalog. Send for a copy today. This catalog also is shown in Sweet's File for Product Designers.

Another achievement in **RUBBER**

engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1982 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

Filing System For Catalogs

W. L. GOVAN
Port Washington, New York

REQUIREMENTS FOR a satisfactory catalog from the user's point of view were offered in an earlier article (June 1954, page 322). Several of these requirements were important for ease in filing. Actual methods of filing are simple. A bookcase is essential for the heavier, hard-covered catalogs, whether small or large. The shelves should be about 10 in. wide by about 15 in. apart, with vertical separators set in about 2 in. from the front edge of the shelves, and spaced horizontally every 12 in. or less. These separators make it possible to file thin catalogs on the shelves, and help prevent wedge-shaped binders from twisting.

Some of the shelves may be closer together for undersize publications. It will be found advisable to divide all bookcase catalogs into two classes, Large and Small; the dividing line being about 4¼ x 5½ in. Many small, thin pamphlets can be converted to Large by inserting them in a folder.

Good quality, standard size folders should also be used for thin, poorly covered or poorly bound catalogs and loose pages. The folders should be of a type in which the fasteners are fully enclosed within the covers so that the outside is smooth. A cheap and satisfactory alternative is to use a plain folder; attach the publication to the back cover only, using a two-pronged flat strip-type fastener. The front cover covers the bulkier front half of the fastener. The result is a folder reasonably smooth on the back, completely smooth on the front, and without a bulky binding. When a manufacturer issues several thin catalogs, which are not in too great demand, they can be grouped together in this way, with or without a folder. In the latter case, both halves of the fastener can be buried in the middle pages of the first and last catalogs, respectively.

Bookcase or File Cabinet?

A bookcase can be used to file all catalogs, if the thin ones are fastened (not merely inserted) in folders. It is then only necessary to know whether

a catalog is Large or Small in order to know where to look for it.

Despite this advantage, many prefer to use drawer-type filing cabinets, in addition to the always essential bookcase. The cabinets are neater, and take up less floor space. They provide maximum protection, and permit greater use of separators and identifying tabs. Papers and pamphets of any size may be filed loose in folders.

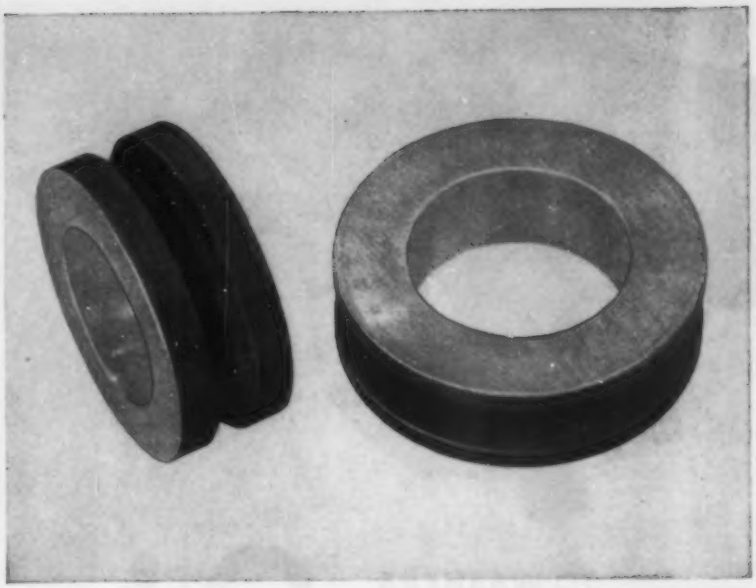
However, the cabinets are more expensive than shelves, and are not as accessible. Only one person can use a cabinet at a time. If a book is filed in a cabinet with the binding up, it tends to break the binding and damage the pages, which may fall out. If the binding is down, the title is hidden. Moreover, the book (and folders too) tend to fall open, and there is danger of filing one publication within the pages of another.

Tabs attached to folders or books for cabinet filing are easily damaged and lost. They also often make the folder too wide for an ordinary mailing envelope for internal company or external mail. All these points must be considered in deciding between shelves or cabinets.

Classification Systems

The logical method of classifying catalogs at first sight appears to be by product. Many excellent methods of doing this have been devised. For example, the Universal Decimal Classification (based on the Dewey decimal system) now used in libraries all over the world could be used. However, as catalogs deal with commodities only and not abstract ideas, the U. S. Standard Commodity Classification is a better choice. This has been adopted, where applicable, by the American Society of Tool Engineers, who publish a "Data Sheet Numerical Index". Many companies publish catalogs and data bearing file numbers according to this index. When this procedure is followed, the catalogs tend to become rather thin, as each can deal with only one product classification. Similarly the American Institute of Architects has established a classification system for building products. Many catalogs of such items are published bearing A.I.A. classification numbers.

Unfortunately, these systems all fail when confronted with the composite catalog covering several products all made by one manufacturer or handled by one sales agency. Such items may be amazingly unrelated and defy any



How Flame-Plating keeps **DOWN-TIME** Down

Deep grooves worn in straightening rollers by small diameter wires often badly score larger wires which are passed through the same set-up. The result—costly machine down-time periods are necessary to change rollers. One manufacturer solved this problem by using rollers Flame-Plated with wear resistant tungsten carbide. Now, machine down-time costs are at a minimum and a better product is produced.

Flame-Plating is a new LINDE process for applying wear-resistant coatings of tungsten carbide to the wear surfaces of parts and many tools made of most common metals. For the full story on how you can solve your wear problems with Flame-Plating, read the new "Flame-Plating" booklet.

CLIP COUPON TODAY FOR YOUR FREE COPY

LINDE AIR PRODUCTS COMPANY, Room 308 G
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

Please send me your free booklet on Flame-Plating, Form 8065

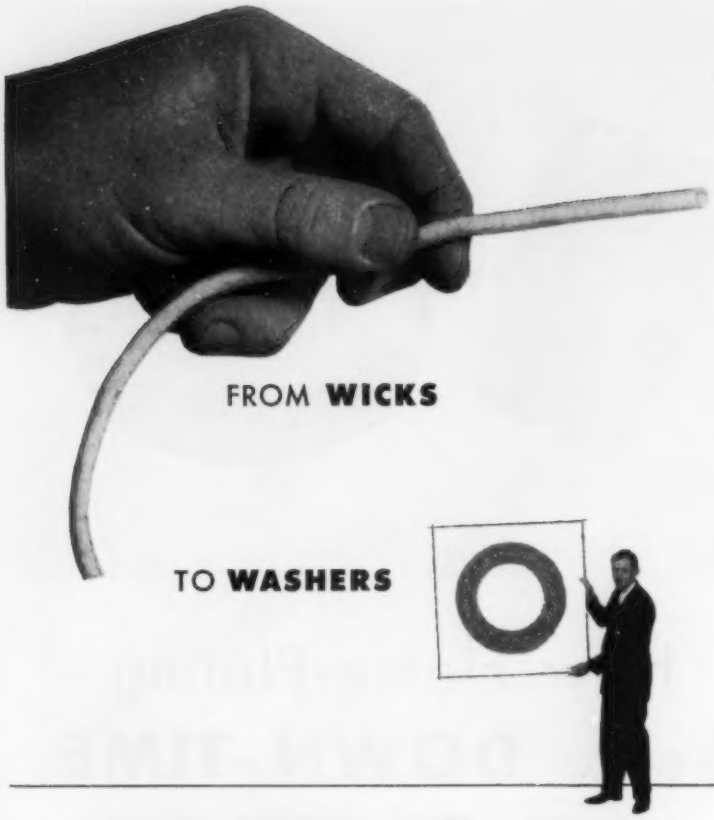
Name.....Position.....

Firm.....

Address.....

City.....State.....

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.



FELT

by FELTERS

DOES THE JOB RIGHT

Wicks that pull oil in — washers that keep dirt out — are two of many jobs done by Felters Felt, to keep equipment in good operating condition.

Hard enough to be ground and chiseled, soft enough to buff a jewel — or any texture in between — each shipment of Felters Felt is uniformly controlled to exactly meet your specs.

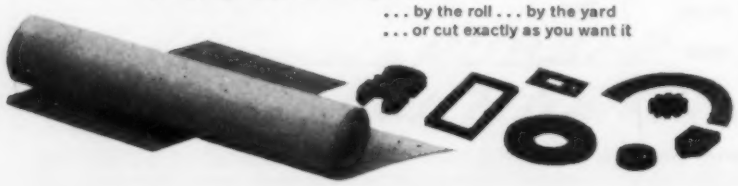
The "Felters Design Book" contains interesting information about several grades of Felt and their uses. We will be glad to send you a copy. Write today. THE FELTERS CO., 228 South St., Boston 11, Mass.

FELTERS S.A.E. F-1 FELT is a grade suitable for oil retention where the felt is not compressed, for feeding light oil, or where unusual strength and hardness are required. Often recommended for use in resisting wear and abrasion.

This is one of many grades of Felters Felt produced for specific applications.

FELTERS FELT

. . . by the roll . . . by the yard
. . . or cut exactly as you want it



common classification. Similarly if a manufacturer does put out individual catalogs for each of his products they become widely separated in the files. This despite the fact that they may be related to each other in appearance and text, and form a very handy volume if bound together.

A second disadvantage is that the Commodity Classification has been designed from the point of view of the ultimate user. Thus, Presses, Hydraulic, Used for Metal Forming are 34-42000. Presses, Mechanical, Used for Metal Forming are 34-43000. Presses, Molding are 31-91000. While the ultimate user might agree that hydraulic and mechanical presses for the same purpose should be adjacent in classification, the machinery manufacturer would prefer that all hydraulic presses be in one main group, and all mechanical in another, no matter what they are used for.

Simplifying Reference Numbers

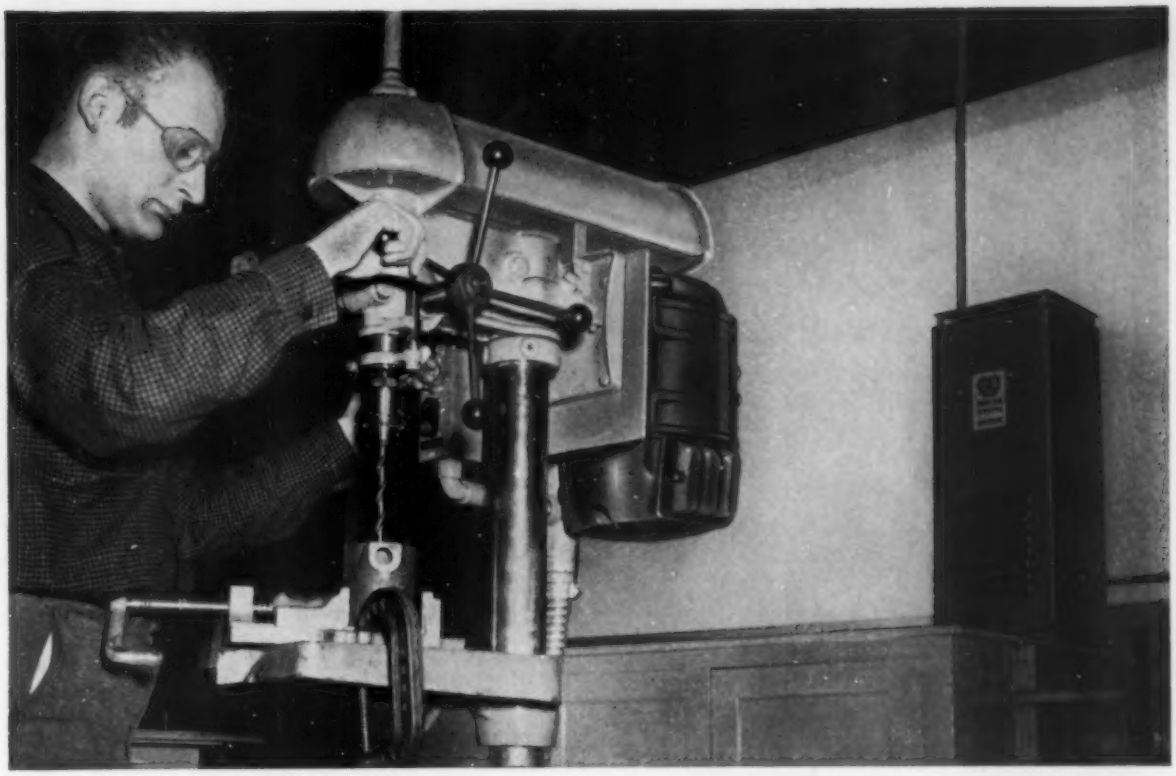
The final disadvantage is that the file reference numbers are necessarily large and hard to remember. Unless an individual is extremely familiar with the file, he is forced to consult the index to locate even a much-used catalog. Compare this with the ease with which company names are remembered.

Against these disadvantages must be weighed the advantages of standardization, of receiving catalogs with printed reference numbers on the cover, and of being able to use a ready-made numerical index and alphabetical cross-reference index. The latter, of course, must still be augmented by card indexes to show what actual catalogs are on file, and to give the manufacturer's name.

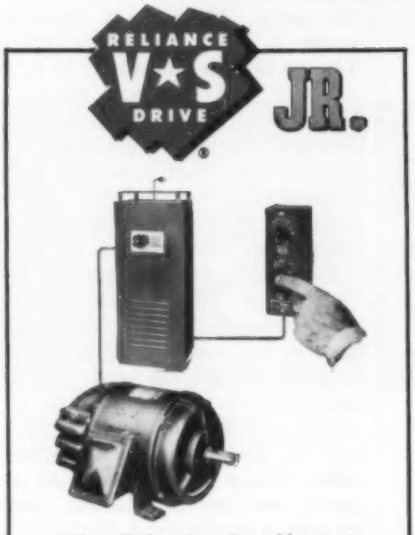
The alternative, and for many purposes the better method of classification is alphabetical by the name of the issuer (manufacturer, sales agency, society, author, etc.) Any publication can be classified by this method—there are no exceptions. Companion volumes issued from one source stay together in the files. Full advantage may be taken of binders issued by many companies to hold groups of their catalogs. As long as the manufacturer's name is known, the catalog is readily found, without any need of referring to a cross-index. The name is usually already on the catalog.

Keeping the File Intact

However, this system is not foolproof unless handling of the files is



THE RELIANCE V★S DRIVE JR.



The all-electric, adjustable speed drive that eliminates mechanical gear boxes, clutches and variable pitch cone pulleys. Ratings from ¼ to 3 Hp.

gives your operator the correct machining speed instantly

Reliance V★S Drive Jr. offers an infinite selection of speeds which permits your operator to use the correct machining speed.

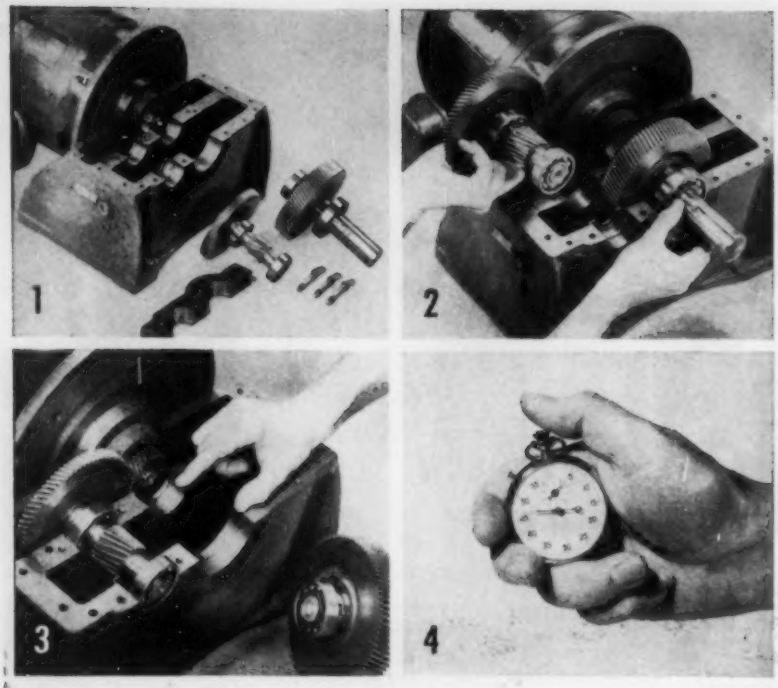
And with the V★S Drive Jr. speed changes can be made instantly by the simple turn of a dial. No time is lost changing belts to adjust for work diameters, the material being machined or for tool changes.

The Reliance V★S Drive Jr. is compact, simple to operate and economical to maintain. Its advantages are helping to increase production and lower costs in many industries.

Write for Bulletin D-2102. It contains all the facts and tells *how* . . . *when* . . . and where the V★S Jr. can serve you best.

RELIANCE ELECTRIC AND ENGINEERING CO.

Sales Representatives in Principal Cities • 1080 Ivanhoe Road, Cleveland 10, Ohio



4 reasons why customers want Westinghouse Gearmotor Drive

Add sales points to your product. Westinghouse Gearmotors, with the exclusive horizontal split case, have many design advantages for you and your customers. Four such benefits are pictured above . . . here's the story behind each!

1. **Case cover quickly lifted** after removing a few bolts. No need to dismount motor, break coupling to driven load or drain oil! All servicing can be done in confined work area.
2. **No intricate subassemblies** exist in Westinghouse Gearmotors. Once case cover is removed, all gearing parts are free for removal. No further dismantling required for gearing maintenance.
3. **Firm bearing support** is assured. Bearings are anchored directly to case foundation, not in subassembly discs or spiders. Machined shoulders hold horizontal thrusts to exact tolerances . . . undue tooth wear and vibration are eliminated.
4. **4.78 minutes to dismantle** a Westinghouse Gearmotor! Each step of dismantling operation was "stop-watch timed". Included in study was time required for removal of end cap, motor, gears and pulling of pinion. Total time required . . . 4.78 minutes; a record that withstands any comparison!

Pass these advantages on to customers. Specify Westinghouse Gearmotors in your machine design. Write for free booklets—*Gearmotors* B-5645; *Speed Reducers* B-5646—to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-07340

YOU CAN BE SURE...IF IT'S Westinghouse

restricted to a permanent librarian. Men in a hurry will not take the time to return a catalog to its correct alphabetical position in the file, except perhaps for the initial letter. This makes it necessary to augment the alphabetical system by adding a file number to each catalog. In effect, the catalogs are filed alphabetically and then numbered in sequence. The alphabetical arrangement need not be perfect, but it should be close enough that a catalog can be found by name.

Suggested Numbering System

Gaps must be left in the numbers for future catalogs. While there are many ways of accomplishing this, the following method may easily be modified to suit individual requirments. Using Thomas' Register, Vol. 3, 42nd Edition there are 1254 numbered columns listing manufacturers alphabetically. To allow for about 9000 names, and so that all numbers would have four digits, the column numbers are multiplied by seven, and increased by adding 1,000. A cardboard scale was made to divide each column into seven equal parts, numbered 1 to 7, and each containing about 10 names at the most. The first listed name in the register falls in the four-seventh section of column one (half way down the page). The name is therefore number $1 \times 7 + 1000 + 4 = 1011$. The last name is similarily $1254 \times 7 + 1000 + 3 = 9781$. PRODUCT ENGINEERING Design Sheets are filed among the catalogs. While PRODUCT ENGINEERING is not listed, if it were it would fall in the two-seventh section of column 918. The file number is $918 \times 7 + 1000 + 2 = 7428$.

Occasionally two catalogs are received from different manufacturers with similar names that fall in the same section, and so normally would be given the same numbers. An adjoining number is used, if it is not already in use; or alternatively the catalogs are distinguished by a decimal suffix. When several catalogs are received from one manufacturer, they are given a letter suffix, A, B, C, etc.

The bulk of the catalogs need no prefix. However, those filed apart from the main group (such as the smaller catalogs) must be given a prefix letter to indicate where they are filed.

Some companies merely number the catalogs in the order in which they are received, ignoring any alphabetical arrangement. This gives no clue, neither

Learn how the

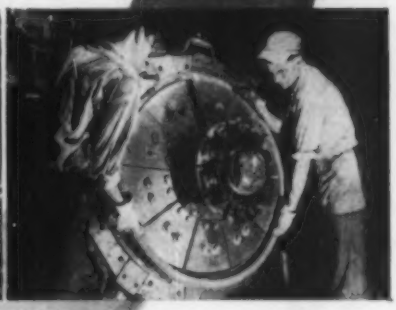
CLEVE-WELD PROCESS

cuts costs of circular steel parts

Ingenious and highly specialized processes now enable manufacturers to obtain certain types of parts at far lower cost than they themselves could make them by conventional methods. One of these is the Cleve-Weld Process for producing circular steel parts. Applicable to carbon, alloy and stainless steel rings over 6 inches in diameter and under 2½ inches thick, this process provides parts free from defects and so accurately shaped that rough-machining is usually eliminated. To describe the Cleve-Weld Process and its applications, we have prepared an illustrated 28-page brochure. We'll gladly mail a free copy to any production executive or machine designer. A handy request form is provided below.

FIRST STEP in Cleve-Weld Process: A straight steel bar is rolled into roughly circular shape.

SECOND STEP: Abutting ends are welded together by electric resistance flash butt welding.



THIRD STEP: Welded ring is stretched then compressed to prove the weld, assure exact diameter.

The CLEVE-WELD Process
for lower-cost circular steel parts

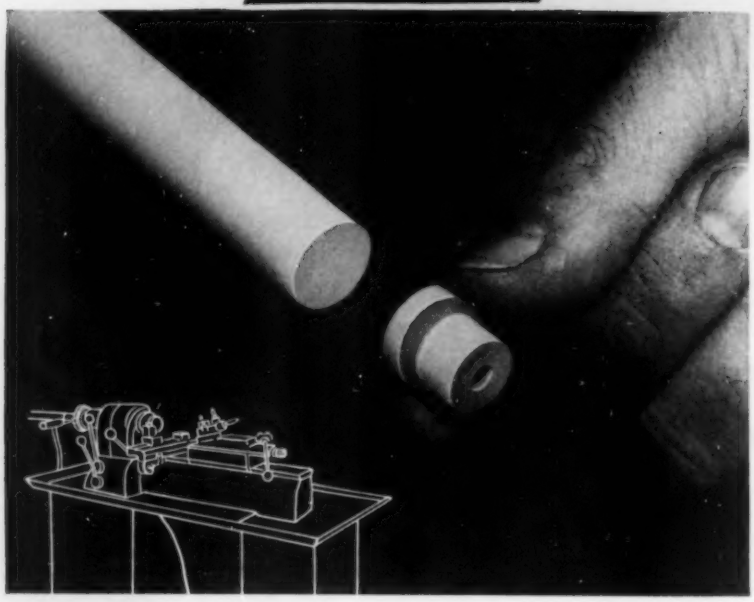
THE CLEVELAND WELDING COMPANY
West 117th Street & Berea Road, Cleveland 7, Ohio
A Subsidiary of
AMERICAN MACHINE & FOUNDRY COMPANY
NEW YORK

products are better...by design

The CLEVELAND WELDING CO., Cleveland 7, Ohio
Please send me your Cleve-Weld Process brochure.

Name_____
Position_____
Firm_____
Address_____

POLYPENCO® NYLON SHAPES



Start Here! and get nylon's advantages
WITHOUT HIGH TOOLING COST

• The product-improving properties of nylon are yours with important savings when you design with POLYPENCO nylon shapes as the starting point. Since tooling cost is practically eliminated, one part or thousands can be fabricated with the same economy. This means that every designer can now obtain nylon's performance in bushings, bearings, gears, packings and many other parts. With POLYPENCO nylon shapes, you also get other advantages:

- Direct control of fabrication on standard metalworking tools in your own shop
- Greater design flexibility . . . closer tolerances in many kinds of parts
- Immediate warehouse delivery of most sizes
- Uniform high quality in every piece
- Technical help . . . also finished parts if desired

Send for new bulletin on nylon shapes.

The POLYMER CORPORATION of Penna. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

POLYPENCO® NYLON
... teflon* and other non-metallics

Warehouse stocks: Reading • Chicago • Los Angeles • Newton (Mass.) • Branford (Conn.)

*trademark for DuPont tetrafluoroethylene resin

by product nor by manufacturer, as to where to look for a certain catalog. Men are lazy about referring to card indexes; they prefer to browse through the shelves, or trust their memories as to the numbers. The result is a great deal of wasted time.

Alphabetical Name Listing

In some cases the problem arises as to what name to use to determine the alphabetical order. The trade-name of the product may be much better known than the company name. The company may be an obscure division or branch of a much better known main office; or the reverse may be true. There may be a choice between the manufacturer's name and the sale agency's name.

In general, the best known name should be selected in each case. However, all catalogs from one source should be filed under one name, unless there are exceptional reasons. The name used should be clearly marked on the outside cover, if different from the name already printed there.

The file number must also appear on the cover, in the most convenient location to assist the searcher. The file number must include the prefix letter indicating where the catalog is filed—small shelves, cabinet, private file, etc. Gummed labels should be avoided, as they often fall off. The time is well spent in putting the information on the catalog cover, or binding, or on the exposed edges of the pages in ink, using contrasting colors when necessary (that is, white ink on a black cover, etc.).

Each Item Dated

Inside the cover of every catalog the date received should be recorded, especially if the catalog is otherwise undated; also the name, address and phone number of the nearest company representative. Any discount information, carefully dated, is also useful. Loose pages, accompanying letters, etc. should be avoided; copy the information or paste in the pages. Reference should also be made to superseded or superseding catalogs, as often an obsolete catalog is not destroyed because it contains useful information not found in the newer edition, or because it pertains to some actual purchase order, etc. Companion catalogs published by the same source may also be referred to, especially if they are filed elsewhere due to a difference in size, or other reasons. If other names

12'0" x 17'0" stainless clad [illegible] tank

BACK IN THE 1880's

WHEN ANNIE OAKLEY JOINED BUFFALO BILL'S SHOW

Koven

WAS MAKING INDIVIDUALIZED EQUIPMENT PARTS

Even when colorful Annie-Get-Your-Gun Oakley was amazing audiences with her expert marksmanship, Koven Individualized Equipment Parts were helping equipment manufacturers speed up production. KOVEN's skill has grown with the industry and today, more and more leading manufacturers are achieving top efficiency with KOVEN special parts built to their individual needs — usually in less time and for less money than could be done in their own plants. See how our vast facilities and superb craftsmen can solve *your* production problems — call or write for a consultation with one of our trained representatives. Of course, there is no obligation. And send for Facilities Catalog #490 and Brochure #550.

Horizontal rotary mixer

Our complete modern facilities include: Machine, welding, plate and sheet metal, galvanizing and painting shops. X-ray equipment insures quality control in every KOVEN Individualized Equipment Part.

PLANTS:

L. O. Koven & BRO., INC.

154-C OGDEN AVE., JERSEY CITY 7, N. J.

KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

When Your Problem is
WEIGHT REDUCTION
Your Answer is
Magnesium

Let's work together to design and make your product of the lightest structural metal. B&P's experience in all phases of Magnesium fabrication is unique in the industry. B&P has its own rolling mill; deep-drawing presses; stretch presses; spin lathes; blanking, routing, sawing, drilling, riveting, spot-and-arc-welding, and finishing equipment unexcelled in the industry.

This 8-page booklet illustrates B&P Magnesium facilities; gives strength-and-stiffness characteristics of structural metals, and suggests many ways that B&P can give you valuable assistance. We'll be glad to mail you this booklet.

LIGHTNESS B&P ...PLUS!

BROOKS and PERKINS Inc.

Pioneer Magnesium Fabricators
1956 W. Fort St. • TAshmoo 5-5900
DETROIT 16

are associated with the product or manufacturer, such as trade-names, head office name, branch, division, subsidiary or sales agency, and are not printed in the catalog, they should be added. If there is any doubt what products are covered by the catalog, these should be listed; this will facilitate making out the index cards. Finally, if the catalog was obtained for one particular estimate, contract, project, work-order or purchase order, a note should be made.

Catalogs must be regarded as expendable. A filing system designed to prevent any loss is not economically justified. Out of print catalogs containing valuable data that cannot be replaced, should be filed in the library with the technical books rather than with the run-of-the-mill catalogs in a catalog file.

Problem of Private Files

The inclination of individuals to regard catalogs as personal property must be diplomatcially discouraged, when the catalogs were obtained on company business. Many suppliers cater to this possessiveness, by issuing catalogs as presentation copies, with the recipient's name inscribed. At least one copy should be in the company file; duplicate copies may be held privately, but should be entered in the indexes with a note as to where they may be found.

When a catalog is borrowed, some record is usually kept. The borrower may be required to write his name and that of the catalog in a ledger, the names being crossed off when the catalog is returned. This is not very convenient to trace when a catalog is missing, although it is the simplest method. For the more popular catalogs, separate ledgers (or indivdual pages in one ledger) may be kept for each catalog, the borrower merely adding his name and crossing it off at the end of the list.

In another system, each borrower is required to leave a slip or a card bearing his name in the primary index next to the index card for the catalog. The card may be large enough and stiff enough to place in the files in the place of the removed catalog itself, as another alternative; or receptacles or hooks may be provided for the cards on the shelves adjacent to the spaces occupied by the catalogs. To prevent all uncertainty, the catalog number should be pencilled on the card beside the borrower's name.

* SINCE 1926 * in the application, design and mfg. of pumps — separators — hydraulic accessories

Simplex & Duplex SEPARATORS

*USCG Approved

*Listed by Underwriters Laboratories

STRAINERS • FILTERS • STANDARD AND HIGH PRESSURE

ELIMINATE LIFTING JACKS

Kraissl Class 72 duplex separators are designed so that you don't need to use a lifting jack to raise the rotary plug valve. The valves are designed to a sufficiently wide angle taper — so that the plug does not wedge on its seat, through wear and use.

Grit, scale and extraneous abrasive matter settle on the seat face, from using a lifting jack. Then, when the plug is returned to its seat and the valve rotated, the seat is galled and scored. This terminates the serviceable life of your separators —and skyrockets your maintenance and overhaul costs.

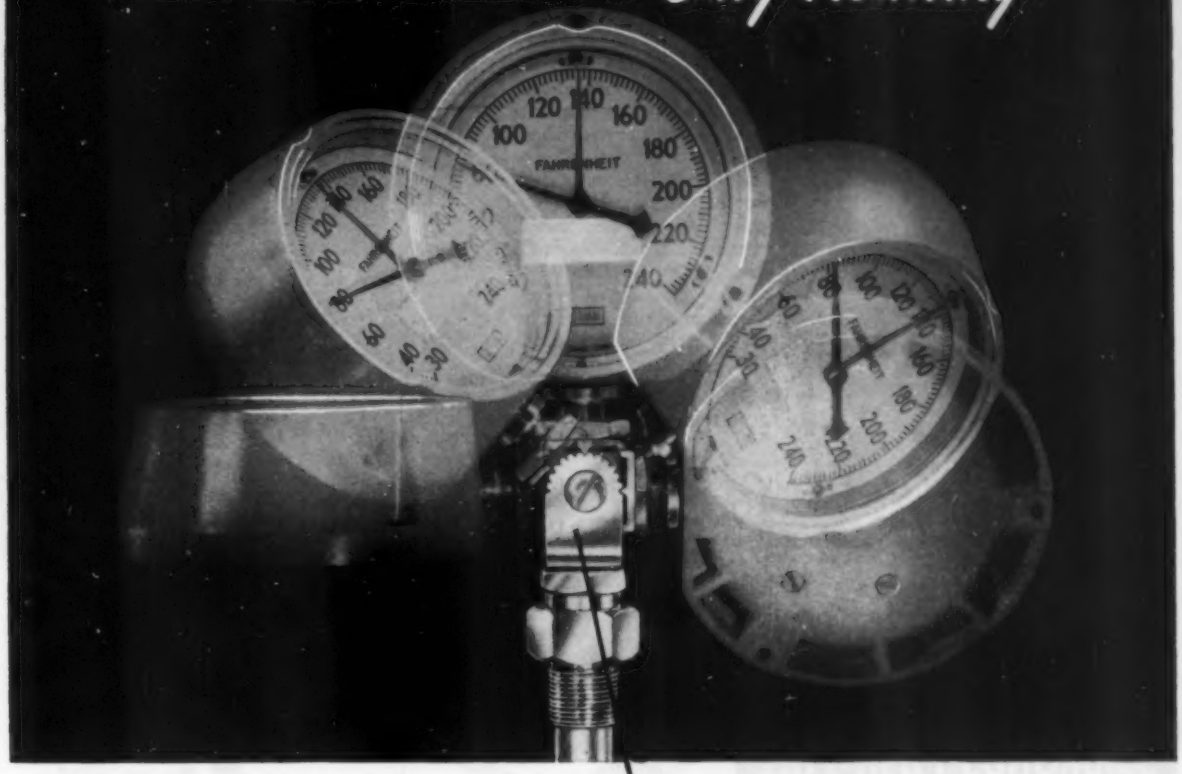
Complete range of sizes — from 1¼" to 6"; pressures to 500 psi. Cast-iron, bronze, steel, stainless-steel, also aluminum, monel or special metals to your specifications.

Bulletin A-1214 gives full data —write for your copy today!

KRAISSL KRAISSL CO

289 Williams Ave., Hackensack, N. J.

Any way you look at it this Thermometer is *Easy Reading*



You've been asking for a dial thermometer like this—A thermometer that can be positioned and firmly locked at any practical angle—now you can have it!

No stretching or straining to see this thermometer. Easy to adjust to required new positions before or after installation. No risk of the multi-angle selector working loose. A specially designed selector assures positive locking at every practical mounting angle and a few turns of *one* nut lock the selector securely.

These instruments, supplementing USG's complete line of Gotham temperature indicators, are designed to fit all standard connections and are available in all standard ranges. If you have a number of applications requiring "odd angle" mounting these new multi-angle thermometers will reduce the number and variety of instruments you have to carry in stock.

Before you order an angle thermometer be sure you see USG's new Gotham Multi-Angle Thermometer.

ADVANTAGES

1. Positive locking in every conceivable angle.
2. Reduces the number and variety of instruments required in your maintenance stock.
3. Provides that extra "odd angle" instrument which normal stock does not furnish.
4. Easy to change to any desired angle, before or after installation.
5. Saves engineers time when writing specifications.
6. Affords easy reading at odd angles.

UNITED STATES GAUGE

Dept. 1
United States Gauge
Division of American Machine and Metals, Inc.
Sellersville, Pa.

Gentlemen:
We'd like to know more about the new USG Multi-angle Thermometer. Please get in touch with us.

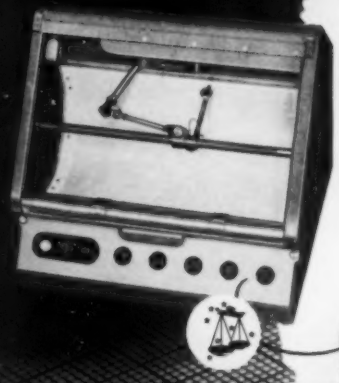
Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

X-Y PLOTTER AND RECORDER



RECORDS TWO INDEPENDENT VARIABLES FROM ANALOG OR DIGITAL INPUTS

A compact, desk-size unit designed for general purpose graphic recording from analog or digital inputs with standard Librascope converters or special modifications engineered to customer requirements. Unique pen travel, fast and dependable. Full chart visibility allowing curve generation to be observed at all times. *Write for detailed catalog information.*

Mechanical and electrical analog computers, digital computers, input-output devices and components.

Computers and Controls

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

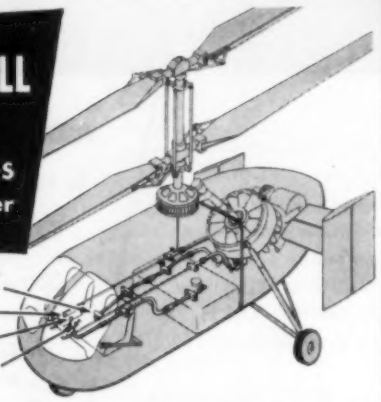
LIBRASCOPE, INCORPORATED

1607 FLOWER ST., GLENDALE, CALIF.

SIMMONDS PUSH-PULL CONTROLS

SOLVE 6 KNOTTY PROBLEMS

In Gyrodyne Model 2C 'Copter


COLLECTIVE PITCH CONTROL INCORPORATING THROTTLE IN TWIST GRIP
CARBURETOR AIR HEAT CONTROL
MIXTURE CONTROL
FUEL VALVE CONTROL

A RANGE OF SIZES, VARIETY OF FITTINGS

Designers of this advanced coaxial rotor helicopter had these problems in laying out the engine controls of this ship: constant high amplitude, low frequency vibration, confined space aft of the firewall, unusual position of the carburetor beneath engine and a requirement for minimum backlash and easy working controls under little leverage. All these requirements were met by Simmonds Precision Push-Pull Control Systems—one of a long list of successful applications of Simmonds controls on advanced helicopters and other military and commercial aircraft.

Write for detailed information on Simmonds Precision Push-Pull Controls.

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CARAVAN AXLES

Improve your Product?

Lower your cost?

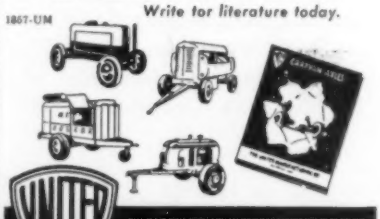
We are AXLE men . . . United's specialization in the axle field gives you the benefit of job-engineered endurance, safety, and long life . . . at lower cost.

For heavy load stability, CARAVAN Axles provide a massive heavy-duty steering arm, extra-heavy center arm stop blocks, a heavy-duty steering knuckle, and precision ground spindles which provide axles with close tolerances. Wide inside wheel turning angle assures maximum maneuverability and eliminates jack-knifing. Axle assemblies are available for two and four-wheel units up to 15,000 lbs. capacity.

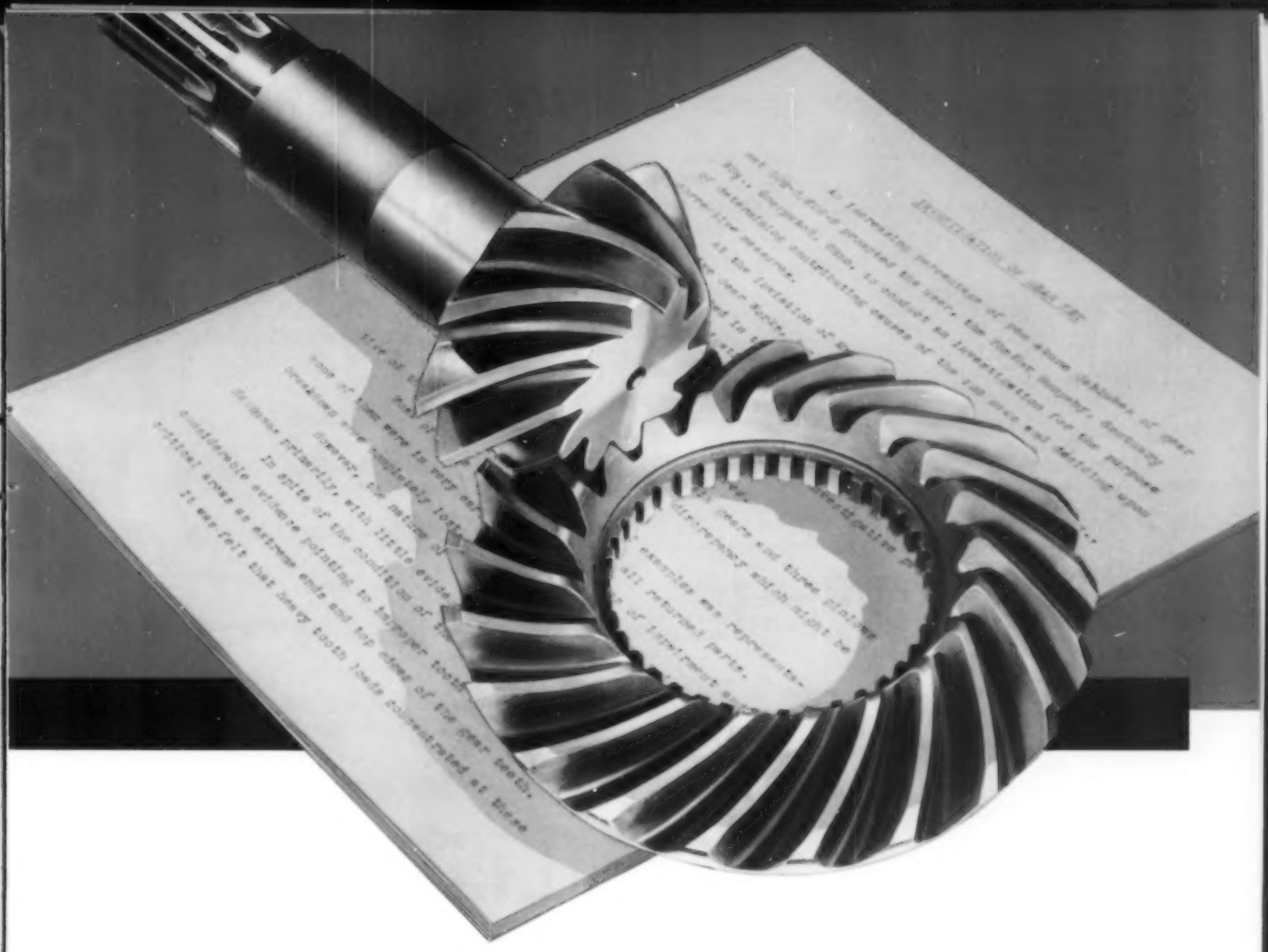
For dependability and lower costs, mount your product on CARAVAN Axles.

1867-UM

Write for literature today.



UNITED MFG. COMPANY



BETTER GEARS

via Pullman and Paper Work

A lot of time, travel, study, and testing can go into the improvement of gears.

The report and gear set shown above is a case in point. The 4,000-word report was prepared from facts gathered at the customer's plant. It details performance factors right down to the ground—pin-points every specification that will produce better gears to do a better job. From this study trial sets were made, tested exhaustively *at* the customer's plant *in* his product.

Then the order was received.

Not all gear problems are as tough as this. But when you're faced with *any* gear problem, write us the facts, telling us where you are and when we can see you.

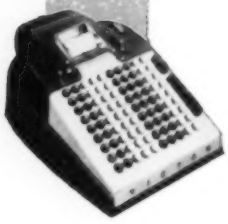
DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

RICHMOND, INDIANA



16 MILLION

TROUBLE-FREE OPERATIONS

...this is the outstanding record of endurance achieved by a Victor Adding Machine powered by a Bodine Motor!

By performing 16,440,705 operations in a recent endurance test, Victor's millionth adding machine reached an equivalent of over 12 years of service at 25,000 operations per week without being repaired, adjusted or cleaned. Maintenance was limited to standard lubrication. And when the test ended, the Bodine Type VVF-12, 1/50 HP motor powering the millionth Victor was still operating at top efficiency!

After completion of the test, Victor's Director of Engineering had this to say—"*As an engineer, I can't think of a more exacting performance test for a motor than to subject it to months of continuous use without servicing. However, even the wear and tear of 16,440,705 machine operations failed to break down the Bodine motor. Frankly, we were not surprised. From the beginning, some four years ago, we were impressed with its low temperature rise, its service free operation and its compact design.*"

Why not test a Bodine motor in your product, and prove to yourself that you are getting the most for your motor dollar? You might find that you can reduce on-the-line rejections, improve product performance, reduce service calls and/or design a lighter, more compact unit. And Bodine offers you a wide variety of standard motors—over 3500 in all types and ratings (1/2000 to 1/6 HP)—and 49 years of small motor experience. For sound motor counsel, call Bodine today.

Bodine Electric Company, 2260 W. Ohio Street, Chicago, Illinois

REPRESENTATIVES IN PRINCIPAL CITIES. IN CANADA: RENOLD-COVENTRY, LTD.

BODINE MOTORS

THE POWER BEHIND THE LEADING PRODUCTS

BODINE

Bodine

FRACTIONAL HORSEPOWER

MOTORS

The Problem: Serious friction problems were preventing the acceptance of a unit manufactured by a nationally known producer of aircraft equipment. Electrofilming, chrome plating and other excellent surface treatments were tested without success. The treatments that reduced friction appreciably failed to meet the corrosion specification. Those that provided the required corrosion resistance failed to reduce friction within the required limits.

How it was solved: Following a meeting held with the engineers responsible for the project, ELECTROLIZED parts were tested. Friction was reduced by 50% and the 100-hour salt spray requirement was met. Repetitive tests established the consistency of ELECTROLIZING to the satisfaction of the authority responsible for the acceptance of the unit. ELECTROLIZING was incorporated in the drawing.

What it means to you: If you are searching for an answer to friction, wear, abrasion, or corrosion problems, ELECTROLIZING is the ideal starting point.

At no cost and without sacrificing project time, you can quickly appraise this process in terms of your own needs. Our 16-page booklet will help you. It describes some of the difficult engineering problems that have been solved with ELECTROLIZING. Just return the coupon for your copy. There is no obligation.

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THE ELECTROLIZING CORPORATION
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More reasons why...

HUNTER DOUGLAS

IMPACT FORGING

FROM

HIGH STRENGTH ALUMINUM ALLOYS

These Impact Forgings are shown three-fourths actual size

These aluminum thick bottom cans are illustrative of the endless variations in part geometry possible with Hunter Douglas cold impact forging.

All parts pictured were formerly produced machined from bar stock at great cost—now impact forged by Hunter Douglas to final print in one fast operation at low cost. The "no-draft" characteristic effectively eliminates machining. Simply trim to length, drill holes in base for attaching bolts and the part is ready for final assembly.

To the economies achieved through impact forging can be added the superior physical properties resulting from this mass production technique perfected by Hunter Douglas. Increased fatigue properties are obtained and bending stresses at the inside corners are redistributed parallel to the flow lines rather than cross grain as would be the case if the part were machined from bar stock.

If you have a design problem that requires a similar part for mass production in quantities up to a million or more a month, remember the name, Hunter Douglas.

Our Research and Development Engineers welcome the opportunity to consult with you.

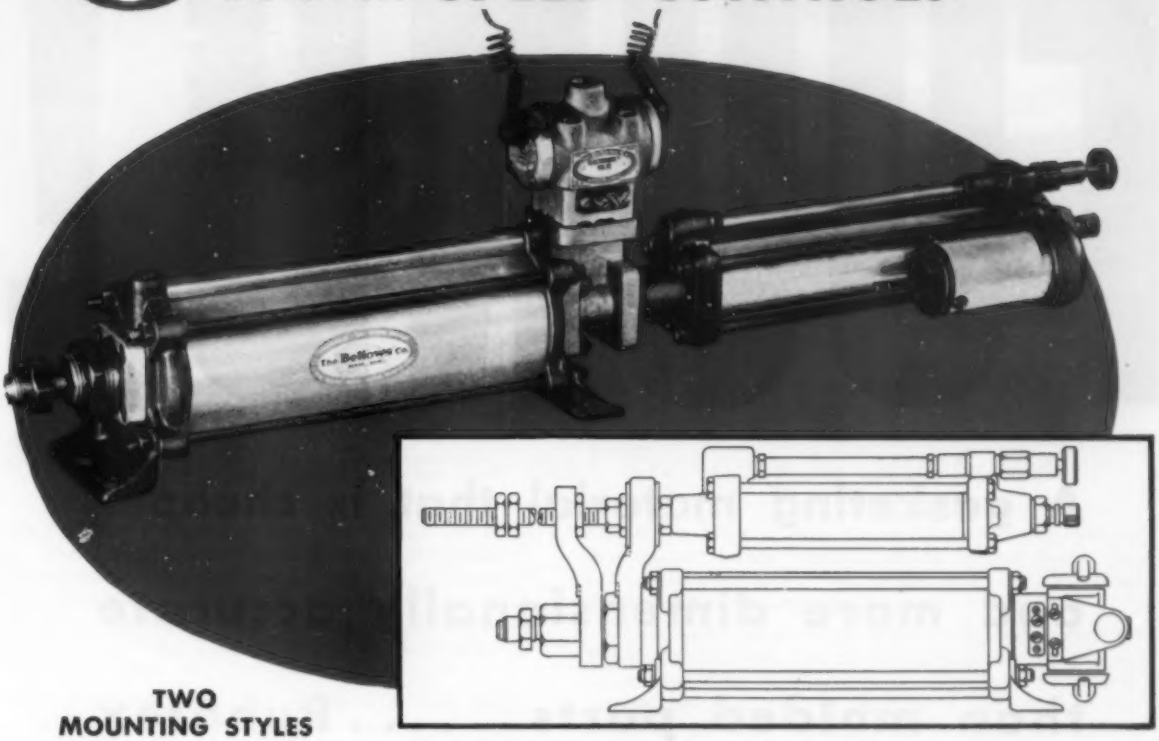
write for free literature on your company letterhead

HUNTER DOUGLAS ***CORPORATION***

DEPT. PE 7 • RIVERSIDE, CALIFORNIA • TELEPHONE RIVERSIDE 7091

This Air Cylinder Combines

1 BUILT-IN HYDRAULIC CONTROL
2 BUILT-IN ELECTRIC CONTROL
3 BUILT-IN SPEED CONTROLS



TWO MOUNTING STYLES

The Bellows Air Motor and Hydro-Check (Model HCB-EM) is available arranged in tandem as shown above, or in parallel, as sketched.

●

Combination units of Air Motor and Hydro-Check are also made with any one of six other Bellows directional valve arrangements; and, of course, Air Motors and Hydro-Checks are available as separate units.

In one compact packaged power unit are built-in controls to cover every phase of air cylinder operation. Built-in hydraulic control of piston rod movement gives the characteristic smoothness of hydraulic operation, yet retains the speed and flexibility of air power. Built-in electrically controlled directional valve permits quick, positive, remote control, or easy electrical synchronization with other machine elements. Built-in speed controls permit exact control of piston rod speed in either or both directions.

This combination of Bellows Air Motor and Hydro-Check is available in five bore sizes: 1¼", 1¾", 2½", 3⅜" and 4½" in standard stroke lengths up to 18".

Here is air cylinder power at its best — fast, flexible, safe, and smooth.

BULLETIN CL-50 TELLS THE STORY. WRITE FOR IT TODAY!
DEPT. PE754

Controlled-Air-Power

The Bellows Co.

AKRON 9, OHIO

FOR FASTER, SAFER, BETTER PRODUCTION

FOUND!

A gasketing material that is cheaper and more dimensionally accurate than molded parts.....Rubatex Closed Cellular Rubber!

What's more — Rubatex offers big cost-cutting advantages in the fact that it can be cut from sheet stocks in soft, medium or firm grades without any need and expense for special coating or molded-on skin.

For air that protects —use Rubatex!

For complete information–Write Dept. PE7, Great American Industries, Inc., Rubatex Division, Bedford, Virginia.

ALSO MANUFACTURERS OF VINYL SHEETS

PHOTO COURTESY STEWART & STEVENSON SERVICES, INC., HOUSTON, TEXAS

quad power unit extends advantages of **CHRYSLER** *Performance and Economy to new fields*

Here's Chrysler Power at work in the South Texas oil fields. This time it is four Chrysler Model 20 Industrial V-8 Engines working together as a single unit in a Stewart & Stevenson Quad Power Unit, in turn driving a mud pump. This particular Quad has supplied mud pump power for the drilling of ten oil wells in the eight months it has been in use.

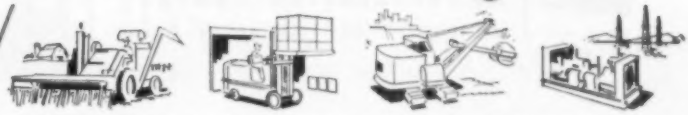
You see Stewart & Stevenson Quads in other fields, too, but nowhere do they encounter tougher jobs than pumping mud—or more important jobs either. The continued flow of mud down the hole being drilled is absolutely necessary if drilling is to continue uninterrupted. That's because mud serves several very important functions: it lubricates the drill bit, it removes bit cuttings, it seals the walls of the hole and it provides weight to prevent blowouts.

Pumping mud requires great power on a continuous basis, power that can "roll" with the heavy pulsating motion of the pump. The 331 cubic inch displacement Model 20 Engine is ideal for a multiple-engine installation. It meets the demand for high horsepower. It is a compact engine, easy to install, low in initial cost, and economical to operate and maintain. Parts are readily available, and at a fraction of the cost of competitive equipment. Each engine is supplied with a Chrysler gyrol Fluid Coupling which absorbs shock loading, thereby enabling smooth transmission of power from all four engines to the common power output shaft. One or more of the engines can be clutched out if less than maximum power is required.

Check your power needs with a Chrysler Industrial Engine Dealer. Ask him about optional equipment too. Remember, Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. If you prefer, write: ***Dept. 57, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

CHRYSLER *Industrial Engines*

HORSEPOWER WITH A PEDIGREE



AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS

SPECIALS may match the prices of STANDARDS

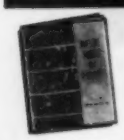
If ordered in fair quantities, recessed hex head screws cost no more than standard machine screws, and actually much less than trimmed hex head screws.

The saving results from elimination of one production operation, without loss of mechanical values. The difference is in appearance. And even that may be in favor of the recessed head.

To order only, made to standard dimensions in sizes to suit your needs or to your specifications.

Get our prices and deliveries on your requirements. In fact write us about special upset, and rolled thread products of any kind. The cost may be lower than you think.

MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS



WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
48 NORWOOD ST., TORRINGTON, CONN.

RUTHMAN GUSHER COOLANT PUMPS

FOR ALL METAL CUTTING MACHINERY

Illustrated is a Cincinnati Gilbert 4'-11" column Radial Drill equipped with a Gusher Coolant Pump.

Ruthman Gusher Coolant Pumps are better three ways

1. Gusher Coolant Pumps give you split-second coolant flow when the machine is turned on.
2. Pre-lubricated heavy-duty ball-bearings, totally enclosed drip proof motor, elimination of packing and priming, cut maintenance to a minimum.
3. Electronically balanced rotating assembly with no metal to metal contact assures long life.

Always Specify Gusher Coolant Pumps

THE RUTHMAN MACHINERY CO.
1818 Reading Road Cincinnati, Ohio

The breeding of Fine Pitch Instrument Gears involves both science and artisanship. Requires craftsmen — not just machinists.

Why? Because these little animals have complex personalities—sometimes hard to deal with.

Now, here we have done nothing else, day after day for some 20 years.

The point is: if you need Fine Pitch Gears — GET THEM HERE.

6829

Dexter MACHINE PRODUCTS, INC.
CHELSEA, MICHIGAN, Box 328
Phones: Detroit WO. 5-2399—Chelsea: GReenwood 9-1791

EEMCO technical bulletin

new motor for small fans, blowers, pumps

light ★ 23½ ounces

small ★ 6 inches long, 2¼ inches in diameter

rugged ★ 2000 hours brush life, minimum

actual size

This new EEMCO motor was designed for a wide variety of uses where a light, compact unit with unusually long life is required. It is tooled for large quantity, low cost production. All cast components are either die, investment, or molded.

The basic design is extremely flexible. Speed can be varied by changes in winding and/or lamination stack length. Wound for 28 volt D.C.; it can be wound for either 110 volt A.C. or D.C.

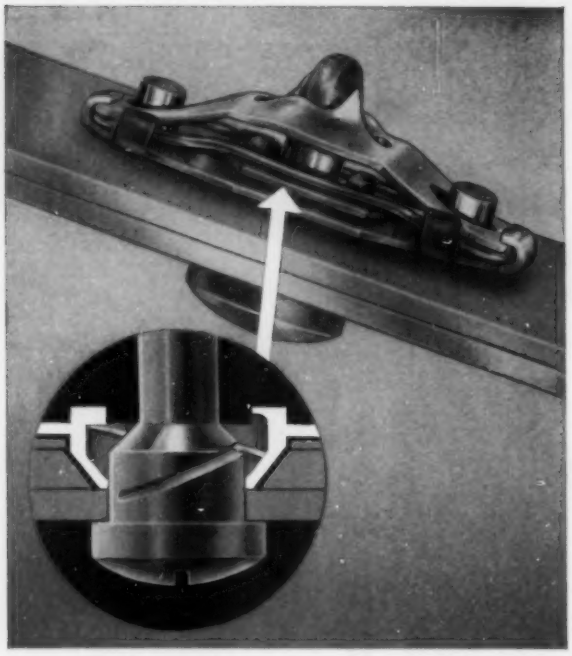
performance data

- ★ 50 watts continuous at 7500 RPM
- ★ 40° centigrade rise at sea level operation and normal ambient
- ★ Weight 23½ ounces
- ★ Dimensions 6 inches long, 2¼ inches diameter
- ★ Brush life at least 2000 hours
- ★ Designed to meet ANM-40 specifications

electrical engineering and manufacturing corporation

4612 west jefferson blvd., los angeles 16, calif.

8-920



New Lion "Hi-Strength" fastener completely assembled. Cutaway shows the beveled counter sink. Beveling substantially increases the area over which stress is distributed.

NOW! Shear strength *twice* that of any other fastener!

NEW Lion "Hi-Strength" design fills every need for parts that must be fastened, taken apart and buttoned tight quickly

Here's a new and better answer to your problem of metal-to-metal fastening where high shear stress and vibration are factors.

It's the Lion "Hi-Strength" fastener, combining speedy quarter-turn opening and closing with a shear strength of 4750 lbs!

This "Hi-Strength" fastener is remarkably strong because shear load is distributed evenly over the area of the fastened parts. The secret lies in the *beveled* counter sink in the sheet and the nut. It's the same high shear principle used for years by the automotive industry for wheel lugs.

In addition to high shear strength, its tensile strength is 3000 lbs. Sheet separation is zero up to 4750 lbs. Misalignment is as much as .125 with high shear qualities. Regardless of the number of times it's opened or closed, there is no wear. It cannot be over-torqued, (up to 3750 lbs.). It cannot be fastened incorrectly. It is no larger than a standard No. 5!

To test it yourself, write for a free mounted working sample. Just drop us a line on your company letterhead.

LION FASTENER, INC.

700 Main St., Honeoye Falls, N. Y.

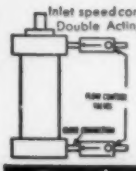
In Canada: A. T. R. Armstrong Co., 50 St. Clair Ave. West, Toronto

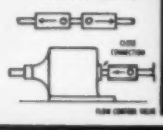
Get Easier, More Accurate Cylinder Speed Control with *Pneu-Trol* VALVES IN AIR OR HYDRAULIC USE

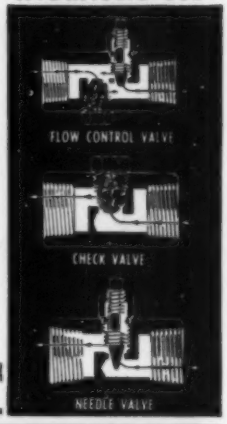
2000 and 5000 (steel) P.S.I.

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in S female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

Write for Illustrated Circular and Price List.



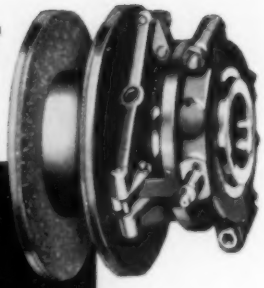


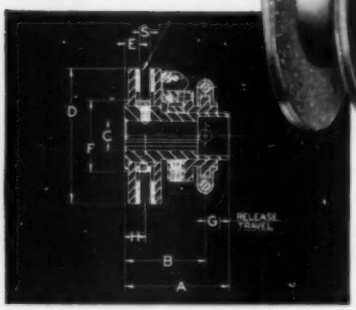


Pneu-Trol Devices, Inc.

1428 N. Keating Ave., Chicago 51, Ill.

LOW COST DESIGN





Before you approve the blueprint for your next model — double check to make sure it includes the latest improvements you can build into your product with the right type and size ROCKFORD CLUTCH. It will pay you to consult our engineers concerning technical clutch advances that will give you and your customers the advantages of better power transmission control.

Send for This Handy Bulletin

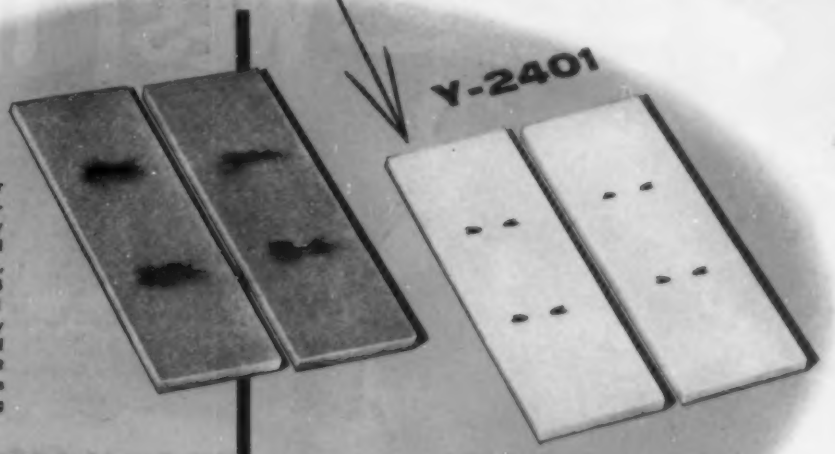
Shows typical installations of ROCKFORD CLUTCHES and POWER-TAKE-OFFS. Contains dia-grams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER

909 Catherine Street, Rockford, Illinois, U. S. A.

ROCKFORD CLUTCHES

this NEW and significantly superior Phenolite Laminated Plastic



Here's a test showing the superior arc resistance of this new melamine-polyester material—Y-2401 by name. All samples were subjected to 5 arcs of 15 KV, 30 milliamps, through a 3/8" gap at a rate of 113 arcs per minute. Note how Y-2401 (two samples at right) showed only minor burns whereas Standard Grade XX phenolic material (at left) was deeply carbonized across the arc, resulting in conducting paths.

EXCELS IN ARC RESISTANCE ...IN MACHINABILITY ...IN ELECTRICAL PROPERTIES

With an ordinary band saw, operator saws out a Y-2401 part to be used in an oil circuit recloser.

In sections up to 3/8", Y-2401 can be shaped by shaving dies as illustrated upper left.

(Center) Y-2401 drills cleanly, without chipping or cracking. Drill tools last longer without resharpening.

Here's the circuit breaker assembly with the Y-2401 parts in place. (Note how this assembly is composed almost entirely of various grades of versatile Phenolite.)

In test after test, this new high pressure laminate actually *created* new standards of performance. The illustration above shows how this new paper base-melamine Phenolite goes beyond current grades in arc resistance.

But that's only a start! Y-2401 does away with the difficult-to-machine aspects formerly encountered with melamine laminates. It can easily be punched, sawed, drilled, turned and milled to close tolerances. And being non-brittle, it can be rough-blanked much closer to final dimensions, thus reducing waste of stock and effecting lower machining costs.

Y-2401 has excellent dielectric strength, good moisture resistance and low dissipation factor. Combine all its good points, and you have the "just-right" insulation material for use in transformers, circuit breakers, switch bases, supports for sliding contacts; in radar, television and radio; in many other critical electrical applications. Available in 39" x 47" sheets, of thicknesses ranging from 1/32" to 1".

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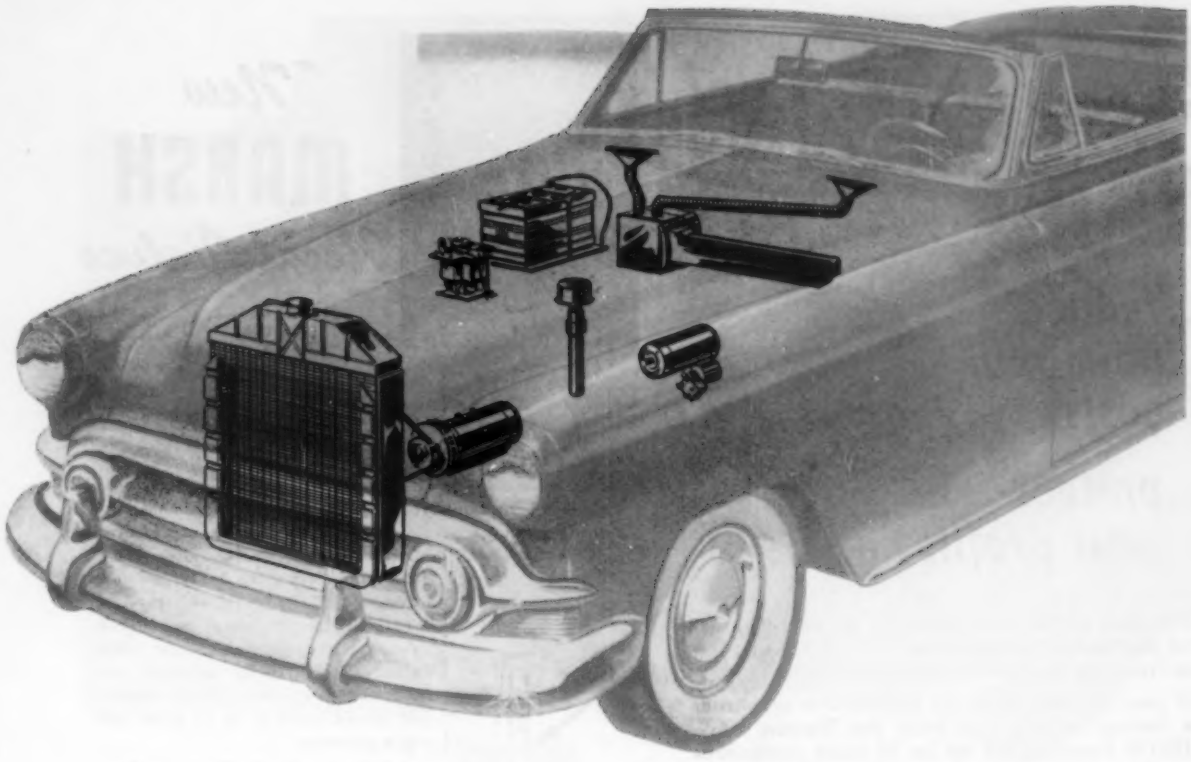

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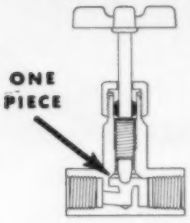

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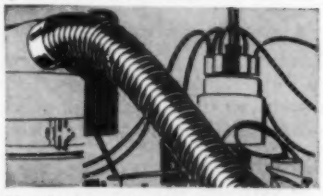

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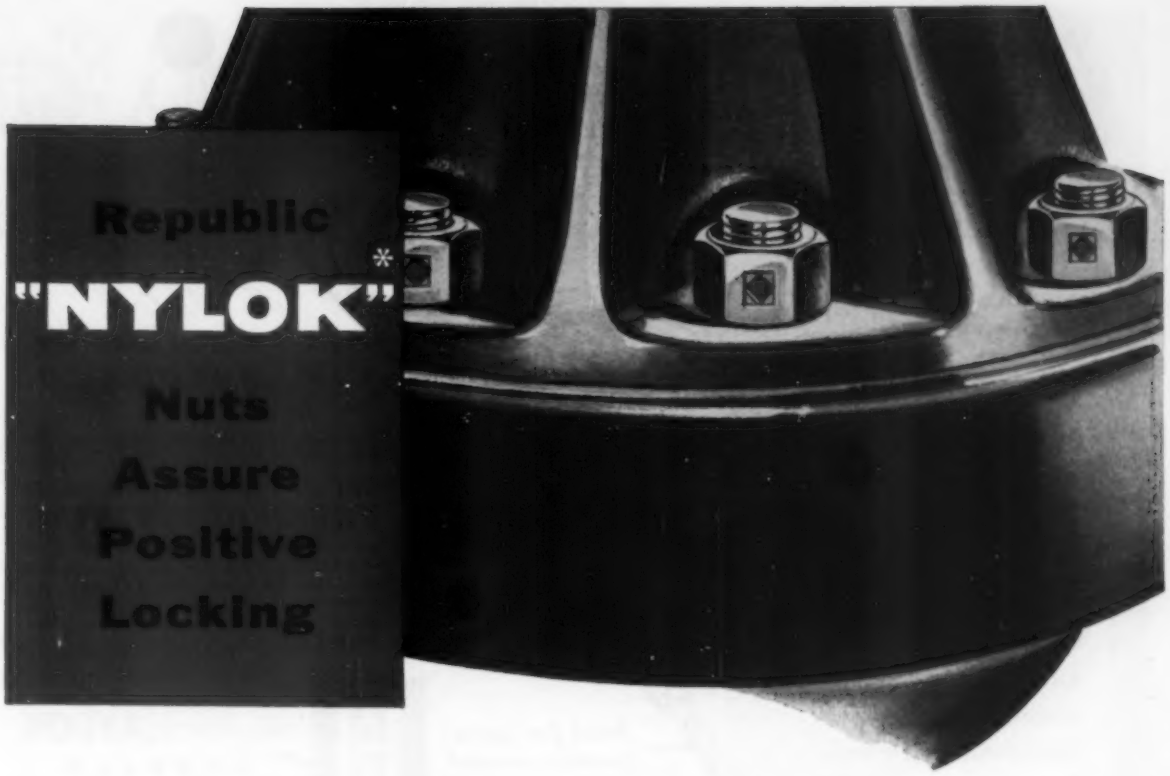

The illustration shows a typical two-piece metal housing. When assembled, a gasket or seal is placed between the two pieces. Republic "Nylok" Nuts are used to assure positive locking even under severe vibration.

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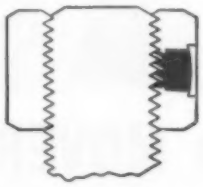

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X-Crepe makes clean, firm edge-binding . . .
Replaces expensive felt, leatherette.

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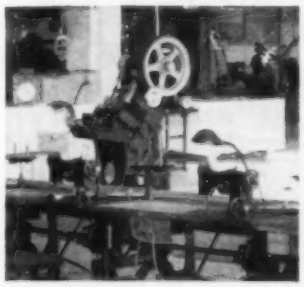
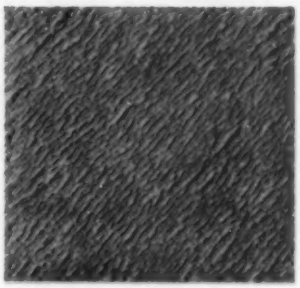
United States Mfg. Corp., Decatur, Ill., world's largest fly swatter manufacturer, used to bind with expensive felt and leatherette. Disturbing field reports indicated this binding frayed, deteriorated—too soon. Blades would kink. Even experienced wielders got too many "misses" and "probables."

Then E. W. Twitchell Inc., Phila., Pa., binding experts, recommended sturdy, economical X-CREPE for the job. X-CREPE won't crack, is pliable, formable, creasable, sewable, easy to work with—perfect for dependable edge-binding.



In the sewing room, X-CREPE is easier to work with than felt or leatherette. U. S. feeds bright-colored X-CREPE from 5/8" wide rolls into binder. X-CREPE creases readily, won't "drag" through binder, doesn't break thread or slow production. Material goes smoothly onto swatter blade, gets high-speed zig-zag stitch on electric Singer Sewing Machines. Out comes another strong, attractive U.S. Swatter.



X-CREPE is pliable, stretchable, formable. It can be impregnated, coated, laminated—or combined with cloth and fibers, films and foils to extend the use of such materials far beyond their usual limits. It can be used like cloth, instead of rubber, in place of cork, and for jobs where no other material will do. Available in a wide range of basis weights—sheets, rolls, die-cut shapes, bags and liners.

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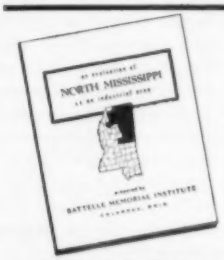

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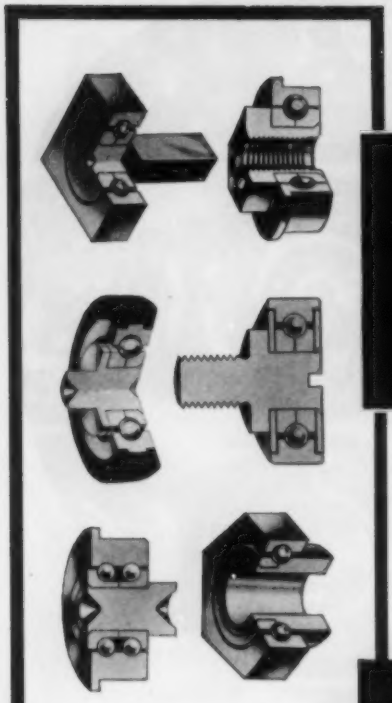

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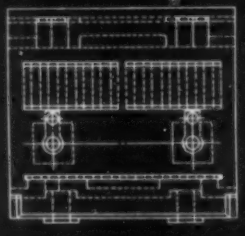

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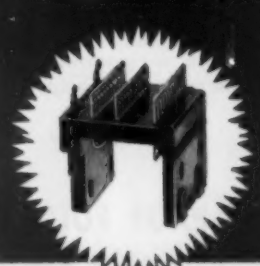

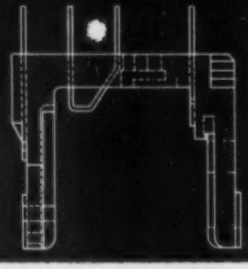

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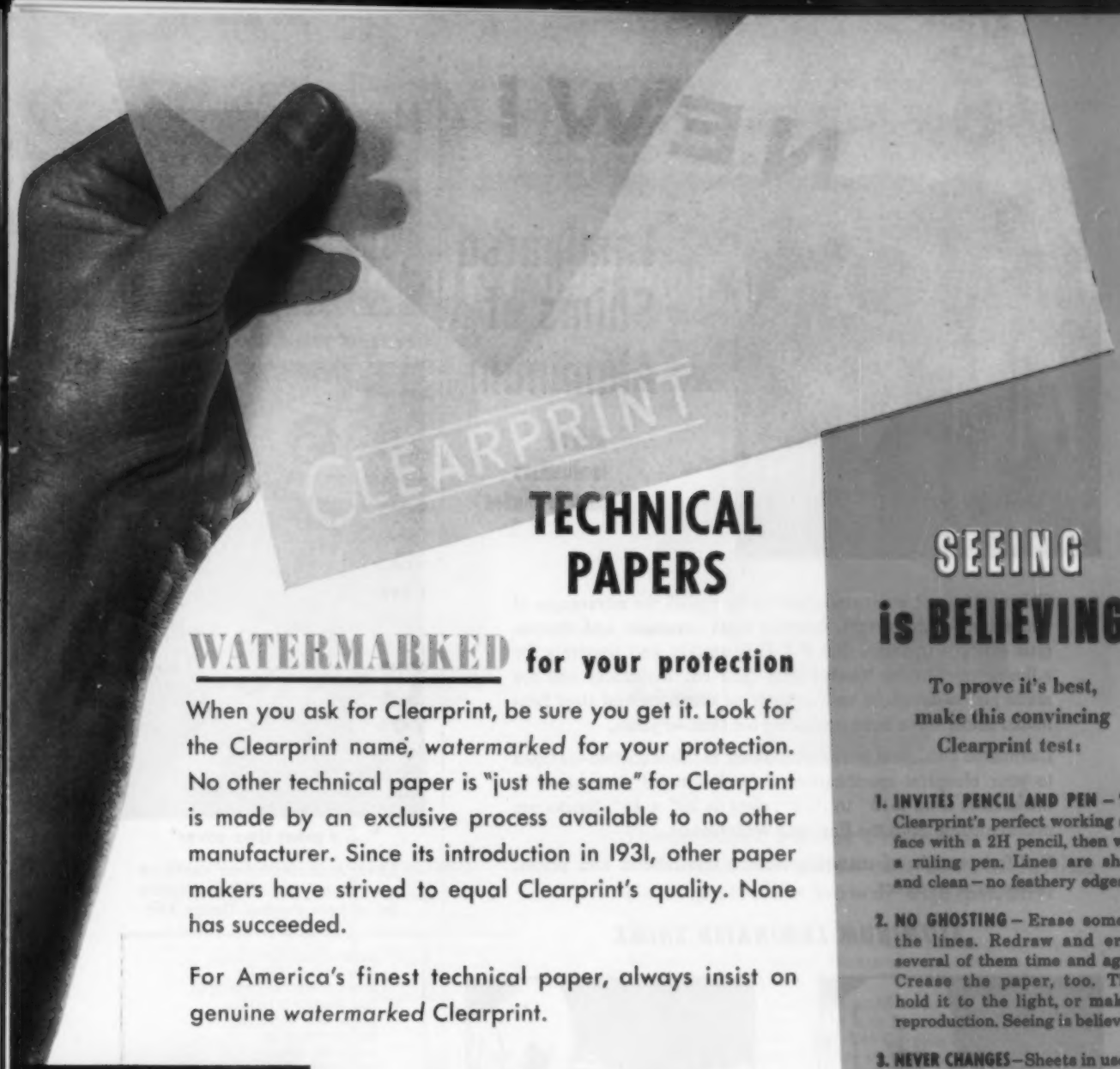

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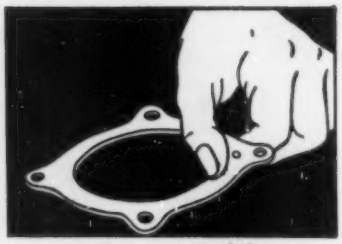

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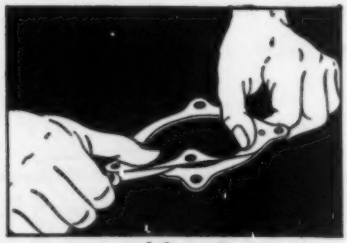

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need information on **transmission equipment?**

reach for your Product Design File

"... a great time-saver"

These manufacturers' catalogs are instantly available in Section 3a of your Product Design File:

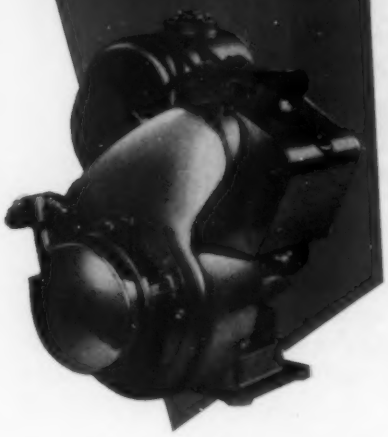
Airborne Accessories Corp.
Allis-Chalmers Mfg. Co.
American Flexible Coupling Co.
Apex Machine & Tool Co.
Boston Gear Works, Inc.
Cullman Wheel Co.
Dodge Mfg. Corp.
Falk Corporation
Foote Bros. Gear & Mach. Corp.
Industrial Gear Mfg. Co.
Instrument Gear Works
James, D. O.,Gear Mfg. Co.
Link-Belt Company
Lovejoy Flexible Coupling Co.
Morse Chain Company
Raybestos-Manhattan,Inc.
Rockford Clutch Div
Stearns Magnetic Inc.
Twin Disc Clutch Co.
Warner Elec. Brake & Clutch Co.
Winsmith, Inc.

In other sections of the File you will find additional catalogs containing useful information on product forms, characteristics, performance and use.

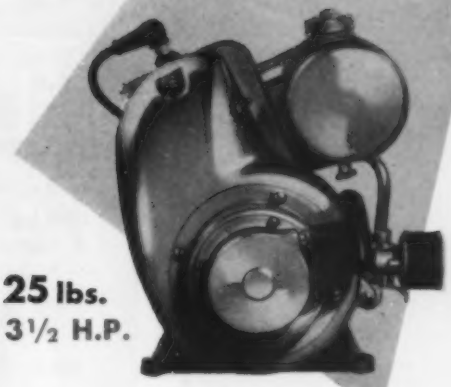
Sweet's Catalog Service

Division of
F. W. Dodge Corporation
119 West 40th Street, New York 18, N. Y.

can Lightweight help your product?



15 lbs.
2 H.P.

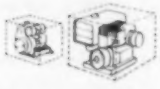


25 lbs.
3½ H.P.

LOOK AT THESE FEATURES

Lightweight
A standard 3½ H.P. industrial engine weighs as much as two and one half Power Products industrial engines of 3½ H.P.

Compact
A unique design makes this engine amazingly compact. A comparison of overall dimensions shows a saving of 72% in size over the standard engine.



LOOK AT THE RESULTS

"Pump and motor weigh only 25 lbs," reports a leading pump manufacturer. This is typical of the kind of amazing lightweight products these engines make possible.

"Only 41 lbs., and usable anywhere, at any angle." Grain auger manufacturers are among the many who have found it possible to revolutionize their products with these engines.

LOOK AT THE PRICE

Despite these advantages, these engines are actually from 6 to 17% lower in price than other available engines of comparable horsepower.

Look to the Power Products Industrial Engine for your products.

These NEW Power Products industrial engines can revolutionize your portable power equipment

No other engine available today can match the weight savings of these new Power Products industrial engines. Not just "a little lighter" these engines actually cut former engine weights in half.

If you make or sell any portable power equipment, you know how important weight is to your customers. You want to save pounds — but with the weight saved by these engines, it is actually possible to revolutionize the entire product — get rid of wheels and carriages — save extra weight and, more important, save dollars.

These new Power Products engines are the result of incorporating, in an industrial engine, the features proved in the famous Power Products engines produced for lawn mowers and chain saws. The resulting engine is lighter in weight — requires less effort to start — is easier to service than any other industrial engine now on the market.

POWER PRODUCTS CORPORATION
2013 N. 12th Street — Grafton, Wisconsin

Gentlemen:

I know what important advantages weight saving can give my products. Please send me full information on these new engines.

Name .....

Company .....

Address ..... State .....

14 "Floating" Precision "O" Rings make this impact wrench work!

This rugged Impact Wrench is compact and efficient because it uses *Precision* Floating "O" Ring Seals. Master Pneumatic Tool Company of Orwell, Ohio, used a new design principle (U. S. Patent No. 2,647,810). The Sealing Assembly is designed so that the "O" Rings float in the grooves, pressing outward against cylinder walls. There is no cross sectional squeeze. This is a new way to reduce break-out friction, lower running friction and provide much longer life for "O" Rings in pneumatic service.

High quality, *compression molded Precision* "O" Rings have proved to be the best solution to a wide variety of sealing problems. How about *yours? Precision* leads the field in engineering help. Send for our complete handbook on "O" Rings and let us help *you.*

FREE—Write for your personal copy of our Handbook on "O" Rings.

Precision Rubber Products
CORPORATION
"O" Ring and Dyna-seal® Specialists

Dept. 3, Oakridge Drive, Dayton 7, Ohio **Canadian Plant at: Ste. Therese de Blainville, Quebec**

Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER

GEAR MOTORS

bring to your product-

- *LOW SPEED*
- *HIGH TORQUE*
- *COMPACTNESS*
- *DEPENDABILITY*
- *LOW WEIGHT*

Many years of specialized experience in the design and manufacture of gear motors combined with the finest gear cutting equipment assure outstanding performance in Lamb Electric gear motors.

Our manufacturing facilities enable us to build the complete range of sizes and types of hobbed and shaped gears for use with fractional horsepower motors. Cutters and finished gears are checked for exactness with a precision gear testing machine.

All Lamb Electric Motors are *specially engineered* for the product, which usually results in savings in space, weight and cost factor.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

In Canada: Lamb Electric — Division of Sangamo Company Ltd.— Leaside, Ontario

THEY'RE POWERING AMERICA'S Finest PRODUCTS

"Pocket-size" gear motor.

Motor with triple thread worm gear reduction.

Gear unit for reversing service.

Gear motor for slow-speed drive.

Gear motor with output shaft at right angles to motor shaft.

Lamb Electric
SPECIAL APPLICATION
FRACTIONAL HORSEPOWER MOTORS

Here's a

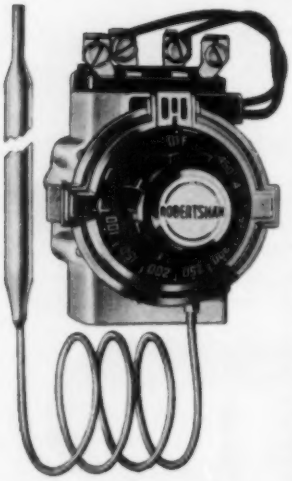
2 CIRCUIT THERMOSTAT

to control:

Hi-Heat to Low Heat

Blower and Heater

Agitator and Heater



Used to control two heating circuits, or to operate a motor when such operation is required in combination with a heater or commercial laundry dryer, etc. where it shuts off current to heating element and turns on signal light.

When thermostat calls for heat, high heat element automatically cuts in and holds until set temperature is reached. Main contacts are then broken automatically and low, or holding, element is cut in to function until drop in temperature again calls for heat. Maximum temperature range 550°F. Write for full information.

Robertshaw® MODEL F-1
Single Pole, Double Throw

Robertshaw
THERMOSTAT DIVISION

ROBERTSHAW-FULTON CONTROLS COMPANY • YOUNGWOOD, PENNSYLVANIA

EVEN THE BEST CAN BE IMPROVED

Gerotor offers its New QDB series of small capacity pumps as proof!

Gerotor has redesigned its series of small capacity pumps to give even more . . .

- **FLEXIBILITY**—the QDB can be operated in either clockwise or counterclockwise direction by simply changing the position of one internal plug!
- **RANGE OF APPLICATION**—the QDB can be obtained with an extended shaft to operate another pump in tandem, off of one motor!
- **DEPENDABLE SERVICE**—the QDB is built to give more dependable service over a longer service span than any comparable pump. Its longer life reduces your maintenance and replacement costs.

If you have need for pumps in the QDB range, call on Gerotor.

Gerotor makes a complete line of hydraulic pumps in ranges from .4 g.p.m. to 40 g.p.m. The Gerotor engineers can help you solve your hydraulic pump problems. Write for *free literature* and full particulars.

Check this capacity table . . .

Delivery g.p.m.—1800 r.p.m.					
Type	Discharge Pressure p.s.i.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

GEROTOR MAY CORP. - Box 86 - Baltimore 3, Md.

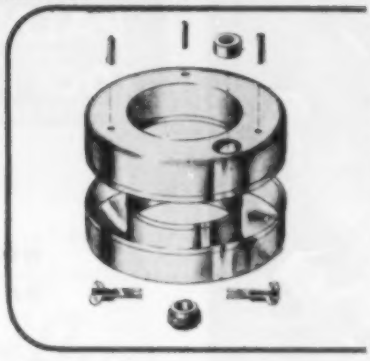
GEROTOR
HYDRAULIC PUMPS & MOTORS

This KampLite Lantern throws new light on a familiar manufacturing problem . . .

NEW PART REQUIRED

Make it or Buy it?

The new KampLite is a real advancement in lantern design. The lamp is mounted below the tank, puts more light where you want it, eliminates shadows.



American Gas Machine Co., Division of Queen Stove Works of Albert Lea, Minnesota, recently faced a familiar problem in modern manufacturing . . . should they invest in the personnel, equipment, and time necessary to produce in their own plant the tanks for their newly designed KampLite . . . or would it be more economical and expedient to purchase the completed tanks from an outside source.

After consideration of all factors Burgess-Norton was selected for production of these tanks. Working together, American Gas Machine and Burgess-Norton engineers redesigned the tank for peak production efficiency and quality control, combining stampings and screw machined parts through hydrogen-copper brazing and projection welding.

Results for American Gas Machine Company:

Capital investment in new equipment was eliminated

Personnel and equipment procurement delays obviated

Additional floor space was not necessary

Manufacturing know-how contributed to a better tank

Costs were 15% less than American Gas had estimated for production of the tanks in their own plant

COMPLETE FACILITIES
FROM DESIGN THROUGH PRODUCTION FOR BETTER PARTS AT LOWER COSTS

The high standard of quality required by industry today begins long before actual production. An experienced staff of engineers and metallurgists, working with the finest equipment, test, examine, and constantly check materials, heat treating and metal-working methods to obtain the maximum in end-use performance.

Burgess-Norton facilities and equipment are extremely diversified for the economical production of a wide range of precision parts, and include complete engineering, development, and metallurgy departments. This engineering service is available to you without obligation. If you have a parts production problem, we believe it will pay you to check into Burgess-Norton facilities. Send prints, specifications, or samples . . . or, if you prefer, one of our sales engineers will call, at your convenience.

BURGESS-NORTON MFG. CO.

GENEVA, ILLINOIS

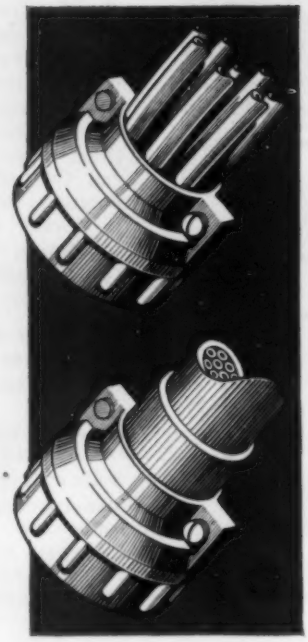
Serving Industry For Over 50 Years

Bendix Builds a Better *cable clamp* the AN3057B

Inexpensive Efficient Versatile

Outstanding Features

- Neoprene gland.
- Centered clamping action.
- Increased close down.
- Positive grounding feature.
- Cadmium plated die-cast aluminum nut.
- Shorter over-all length.
- Waterproofs multi-conductor cable.
- Immediate delivery.



The new Bendix AN approved AN3057B cable clamp is now available. Engineered by Bendix to the highest quality standards, this cable clamp offers major design improvements. The clamping action is radial and completely eliminates wire strain and chafing by holding the wire bundle firmly in rubber. This clamp will accommodate a wide range of wire bundle sizes, but an even greater range can be handled through the use of the Bendix AN3420A accessory telescoping sleeve.

The new AN3057B cable clamp will also waterproof multi-conductor rubber covered cable on the rear of a connector, or where moisture-proof entrance through a bulkhead or into an equipment box is required.

This versatile clamp is a product of the Scintilla Magneto Division of Bendix Aviation Corporation and is a companion AN accessory to the world famous Bendix Scinflex line of electrical connectors. Write our Sales Department for details.

Bendix

SCINTILLA DIVISION of Bendix Aviation Corporation SIDNEY, NEW YORK

FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank Calif. • American Bldg., 4 S. Main St., Dayton 2, Ohio • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • 512 West Ave., Jenkintown, Pa. • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 8401 Cedar Springs Rd., Dallas 19, Texas • EXPORT SALES: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

Low-priced WING NUT for light assemblies

Wing Type PALNUTS combine the convenience of finger tightening, with the security of spring steel locking action that defies vibration . . all at lower cost than ordinary wing nuts. Wing Type PALNUTS are available in #8-32, #10-32, #10-24, ¼-20 and ⅝-18 sizes, in choice of cadmium, nickel, chrome or other finishes to order.

Send for free samples, prices and literature.

— —*provides all these advantages at lower cost than plain wing nuts*

- Built-in locking action that stays tight until finger released.
- Precision-made to accurately fit standard threads.
- Easy finger tightening or removal, due to ample wings.

WING TYPE PALNUT TRADE MARK LOCK NUTS for quick, secure fastening at low cost

The PALNUT Company
65 Cordier St.,
Irvington 11, N. J.
In Canada:
P. L. Robertson Mfg. Co., Ltd.
Milton, Ontario

NO COMPETITOR DARES COPY

Your Name Plate

Make it WORTHY Of Your Product

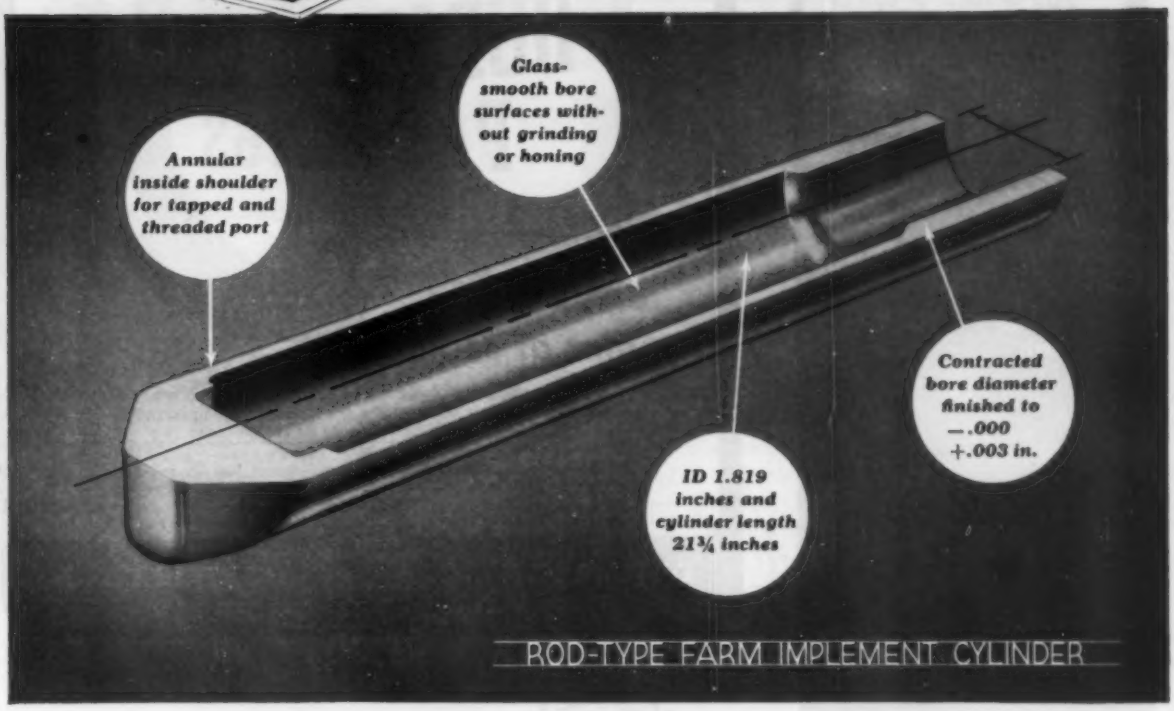
As the maker's "signature," your name plate is one thing that can set your product apart from all others. Make it *distinctive*, and let it reflect the quality you offer.

Let us help you create such a "signature." Our skilled craftsmen, long experience and modern equipment insure finest results. Send a rough sketch or blueprint for design suggestion and quotation.

Write now for "Etched or Lithographed Metal Products," with full color examples of name and instruction plates.

CHICAGO THRIFT-ETCHING CORPORATION
1553 N. SHEFFIELD AVE., CHICAGO 22, ILL., DEPT. B
SUBSIDIARY OF DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA

Now **Mullins Koldflo** *makes your dream design* **practical**


Annular inside shoulder for tapped and threaded port
Glass-smooth bore surfaces without grinding or honing
Contracted bore diameter finished to —.000 +.003 in.
ID 1.819 inches and cylinder length 21¾ inches
ROD-TYPE FARM IMPLEMENT CYLINDER

In this rod-type farm implement cylinder — many costly operations can be eliminated...

Mullins *Koldflo* will extrude this finished part in one piece... *without machining*

- **You can now design intricate steel parts the way you want them — without compromise**
- **You can add important new sales features**
- **And Mullins Koldflo design cuts your costs**

WRITE FOR THIS FREE BOOKLET
"How would you tool-up to make an egg?"

MANY of the manufacturing limitations that have plagued creative design engineers are a thing of the past! Now—with the remarkable Mullins *Koldflo* process, you can design intricate steel parts for *one-piece* mass production! A phone call will bring an experienced Mullins *Koldflo* sales engineer to your office—ready to help you design parts that can be mass produced by the Mullins *Koldflo** process! Write for booklet *"How would you tool-up to make an egg?"* *Trade-Mark

DISTRICT SALES ENGINEERING OFFICES

New York	Detroit	Chicago
500 Fifth Avenue	18268 James Couzens Highway	332 South Michigan Avenue
Phone: Pennsylvania 6-2773	Phone: Diamond 1-1490	Phone: Harrison 7-3725

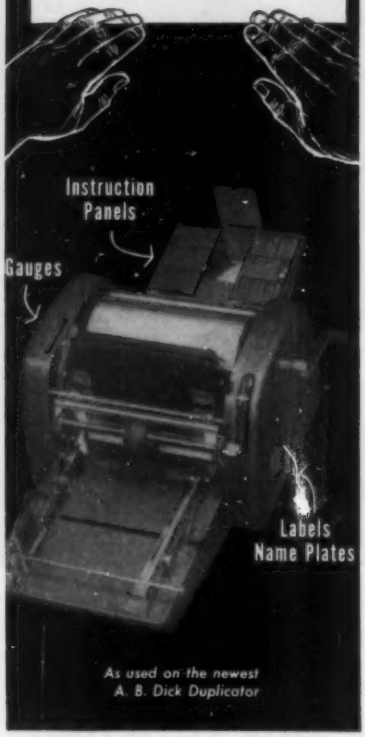
Koldflo
DIVISION
MULLINS MANUFACTURING CORPORATION
Salem, Ohio

Phone — Salem 8771

Make your message clear with

Metal-Cals®

...the anodized, dyed metal foil identification medium



With Metal-Cals, you can have the bright, *lasting* quality of *metal* nameplates without the cost of drilling, screws, rivets and expensive application labor.

Metal-Cal is made from .003-inch aluminum foil with your design created in the brilliant metallic color of the anodized and dyed surface. Easy to apply to any smooth cohesive surface with Metal-Cal's original pressure-sensitive adhesive.

Get the full facts on Metal-Cal—the mark of quality on a growing list of America's fine products.

Write for the new **BASIC DATA FILE** and samples of Metal-Cal for your own tests.

Metal-Cal, Dept. H-4
C & H SUPPLY CO.
415 E. Beach Ave.
Inglewood 3, Calif.

DURAMETALLIC PACKINGS
SAVE at the point of sealing...
Repacking time costs money! That's one reason why it pays to specify Durametallic self-lubricating, long-lasting packing for your specific sealing need.
Write today for File No. DMPG... it will be an important step toward securing the right packing for your particular equipment and sealing problem.
Durametallic Products are "Engineered For The Job"
The PERFECT SEAL
DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

you could make your own suit...

But it's better business to have an experienced tailor do it — right!

Coils are the same way. Maybe you make your own — but usually we at Coto-Coil can make them for you faster, better and at lower cost. It's our business to know the best types of materials for each type of coil. We have time-saving automatic equipment, the most modern testing devices. And we bring to your job nearly 40 years of coil design and manufacturing experience.

Find out how this combination can save costs for *you*.

Coto-Coil Company, 61 Pavilion Avenue, Providence 5, R. I. New York Office: 10 East 43rd Street, New York 17, N. Y.

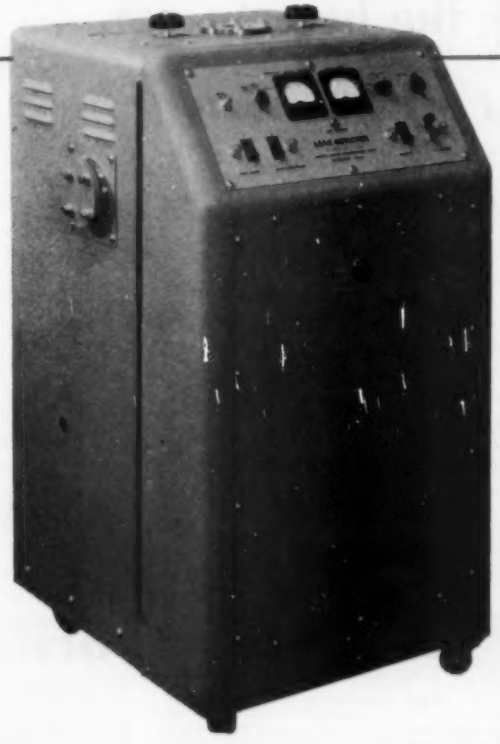
Coto PRECISION WOUND **Coils**

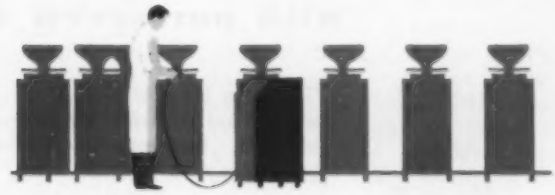
Sensitive to 1 part in 2,000,000

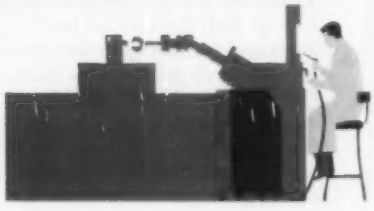
Consolidated's new Model 24-110 Leak Detector

For leak detection applications where the utmost in sensitivity is required, Consolidated's new Model 24-110 Leak Detector meets the most stringent requirements. The latest addition to the Consolidated leak detector line is a modification of a high precision instrument built by CEC for the Atomic Energy Commission. Operating on the mass spectrometer principle made famous by CEC's widely used Model 24-101A industrial leak detector, the sensitivity of the 24-110 has been multiplied by a factor of 10 through advanced electronic techniques. Its uses include testing of both evacuated and pressurized equipment, revealing the existence or the absence of leaks, finding the locations of leaks, and determining the rates of leakage. Outstanding features include: an audible alarm whose sound-pitch varies with the magnitude of the leak; an accessory sampling probe for rapid pressure-system leak testing; a selector switch that provides six ranges of sensitivity; a visual leak-rate meter capable of indicating the presence of 1 part helium in 2,000,000 parts air. Compact, self-contained and mobile, Consolidated's new Model 24-110 Leak Detector is a perfect tool for highly critical applications such as detection in ultra high vacuum laboratory equipment, leak-checking of TV color tubes, and safety control in nuclear material manufacturing.

Request Bulletin CEC 1838-X2



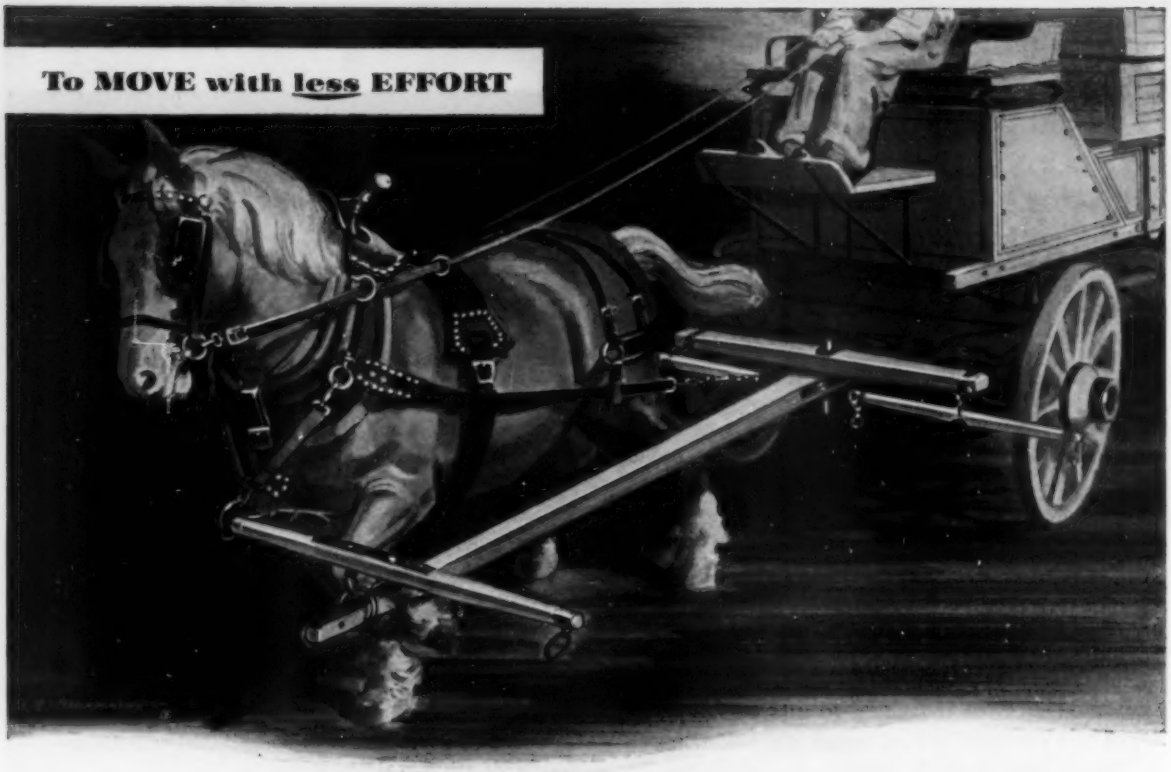




Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

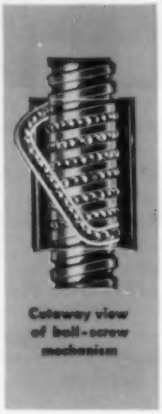
ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

Sales and Service through
CEC INSTRUMENTS, INC., *a subsidiary with offices in: Pasadena, Atlanta, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*



You need only half the horsepower

with our screw that rolls on balls



Cutaway view of ball-screw mechanism

There's a lot of difference in size and weight and electrical requirements... *and* cost... between a 4-horsepower and an 8-horsepower motor.

That's why one of Cleveland Pneumatic's AEROL Ball-Screws is used to safely lower and quickly raise the 2600-pound, 48-foot-high tail fin of a giant aircraft for maintenance. The ball-screw, 13 feet long, is powered by a handy 4-horsepower motor... ordinary high-friction screws would require at least an 8-horsepower motor to do the same job.

AEROL Ball-screws move on a stream of friction-reducing steel balls and are used for many jobs. They can move a mechanism to an *exact* stopping point, with no drift, no hunting, no plus-or-minus tolerance... they can multiply the speed of a drive, yet lose less than 10% of the input power through friction... they can help a motor use less of its muscle to overcome friction, more of its power to do useful work. They are doing all these jobs, and a growing list of other idea-provoking jobs, *now* for many industries.

Write today for Booklet E-7 which describes AEROL Ball-Screws and gives data to help your engineers make horsepower do more useful work. Tell us your problem in as much detail as possible.

Cleveland Pneumatic
Tool Company CLEVELAND 5, OHIO

Department E-7

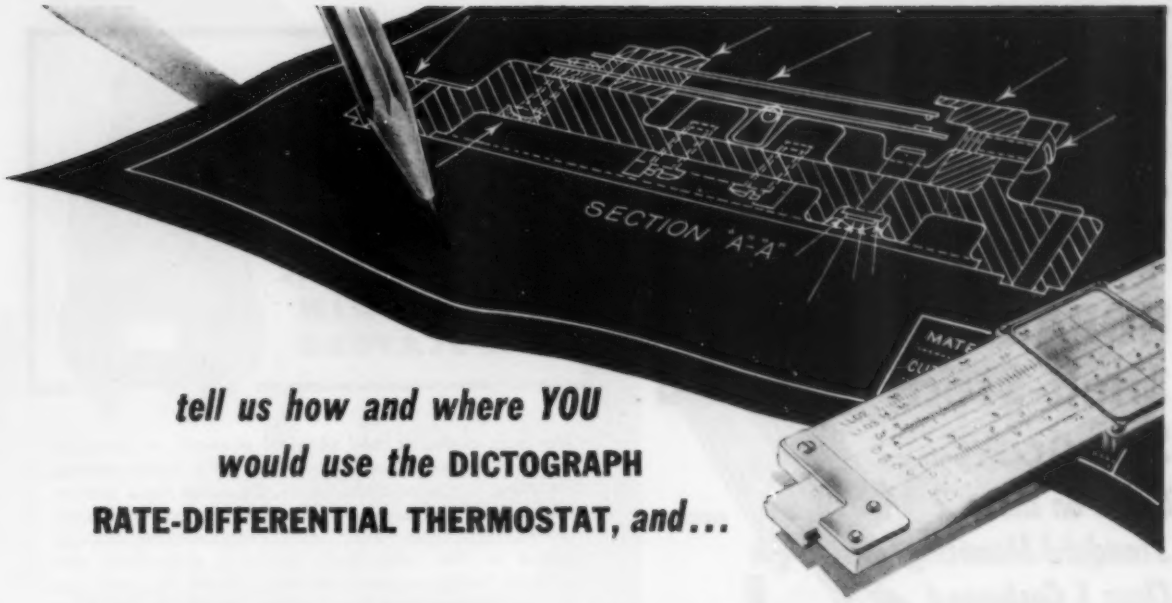
BALL-SCREW MECHANISMS AIR-OIL IMPACT ABSORBERS

World's Largest Manufacturer of Aircraft Landing Gears

To CUSHION SHOCK

CPT's shock absorber principle combines pneumatic and hydraulic cushioning. It can control minute vibrations or tons of impact. It is the shock absorber for the largest aircraft landing gears (CPT is the world's biggest manufacturer of landing gears), and the same principles are often adapted to finger-sized units. May we discuss with you how to take the shock out of stopping or the motion out of vibration?

Cutaway of shock-absorber mechanism →



tell us how and where YOU would use the DICTOGRAPH RATE-DIFFERENTIAL THERMOSTAT, *and...*

WIN UP TO $1,000

Dictograph . . . world leader in precision detection devices, has just developed the most advanced thermostat available today. There are so many possible uses for this remarkable invention, we're sure we've overlooked some. We think you might be able to help us. If so, you can win up to $1,000 cash. We simply want *your* suggestions of "places to use" the *Dictograph Rate-Differential Thermostat* . . . or the R-D.

THIS IS WHAT THE DICTOGRAPH R-D DOES!

Most good thermostats will go into action at a specific pre-set temperature. But ONLY the *Dictograph R-D thermostat* can be set to operate at both a pre-set temperature and any specific *rate of temperature change*. For example, if the Dictograph R-D is calibrated to operate at a temperature increase of 15° per minute, and the temperature goes from 45° to 60° (or any other 15° differential) within one minute, the Dictograph R-D will function.

This means, for example, that you can now operate machinery, motors, test equipment, etc. without the safety margin required with "fixed temperature only" thermostats, because the Dictograph R-D will warn you as soon as the danger condition *starts*.

In addition, the Dictograph R-D will perform flawlessly regardless of the medium in which it is used . . . submerged in liquids, encased in solids, or suspended in air or gas. It can be changed in size and shape to fit almost any requirements, and calibrated to detect almost any temperature differential.

THIS IS WHAT YOU DO TO WIN $1,000!

Just tell us where you think the Dictograph R-D could be effectively used, either in your industry, or any other field. Put your suggestions in a letter . . . if necessary attach drawings or diagrams. If our engineering panel decides that your suggestion is the most practical and purposeful, *YOU WIN $1,000.* Ten other awards of $100 each will be made for the next ten most practical and purposeful suggestions. There is no limit to the number of entries you can make. (see contest rules below) But all letters must be postmarked before midnight, August 31, 1954 to be eligible.

WRITE US TODAY!

CONTEST RULES

1. All persons now residing in the United States or Canada are eligible, except members of Dictograph Products, Inc., their Advertising Agencies, and their families.
2. All suggestions must be in letter form, and addressed to:
   R-D Contest Department,
   Dictograph Products Inc.
   95-25 149th St.
   Jamaica 35, New York
3. There is no limit to the number of suggestions.
4. All letters must be postmarked by midnight, August 31, 1954.
5. In the event that duplicate ideas are submitted, the one bearing the earliest postmark will receive consideration.
6. All letters, entries and modification of entries become the property of Dictograph Products Inc., and cannot be returned.
7. Entries will be judged by The Dictograph Engineering Department. All decisions are final.

DICTOGRAPH
Time vs. Temperature

Dictograph

Factory and Offices, Jamaica 35, N. Y.

Now in its 6th year

NOPAK Shelf-Stock Service...

based on these 2 Standard Mounting, Class 1, Cushioned Cylinders

LIST PRICES F.O.B. Milwaukee, Wisconsin

STOCK STROKE LENGTHS — Double Acting Cylinders									
Cyl. Dia. Bore	1"	2"	3"	4"	6"	8"	10"	12"	15"
1½"	24.16	25.72	26.08	26.44	27.16	27.88	28.60	29.32	30.40
2"	26.24	27.88	28.32	28.76	29.64	30.52	31.40	32.28	33.60
2½"	32.36	34.12	34.68	35.24	36.36	37.48	38.60	39.72	41.40
3"	35.04	37.28	37.92	38.56	39.84	41.12	42.40	43.68	45.60
4"	40.84	43.68	44.52	45.36	47.04	48.72	50.40	52.08	54.60
4½"	48.96	51.92	52.88	53.84	55.76	57.68	59.60	61.52	64.40
6"	66.60	70.90	72.20	73.60	76.40	79.20	82.00	84.80	89.00
8"	.....	126.80	129.20	131.60	136.40	141.20	146.00	150.80	158.00

By specifying NOPAK Shelf-stock, you buy quality cylinders at the lowest possible prices, you eliminate waiting for "specials", reduce engineering costs. Compare the prices and scope of NOPAK Shelf-stock (1½ x 1" to 8 x 15") with competitive offerings — and you will specify NOPAK. ●

● Basic mountings "A" or "E" convertible to "B", "C", "D" or "F", (see below) by changing cylinder heads. Add 10% to above prices, (no extra charge 8" bore). ● Piston Rods NF male thread. ● Cushioning can be eliminated on rod, blank or both ends by removing spring and ball-check.

NOPAK 4-Way Valves, hand, foot, solenoid, or pilot operated, to activate all cylinders, also in Shelf-stock.

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NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

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A 8003-½

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WITH UNIVERSAL PORCELAIN INSULATORS

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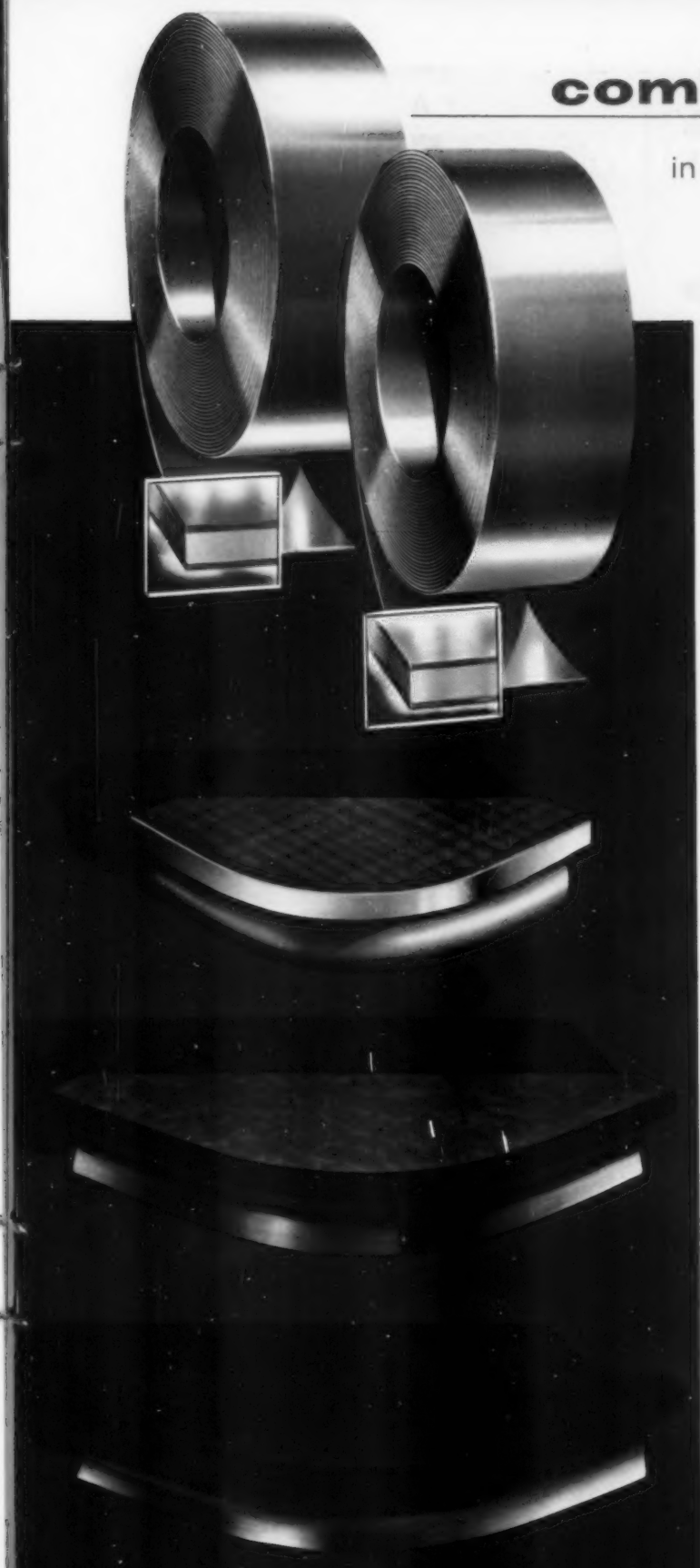

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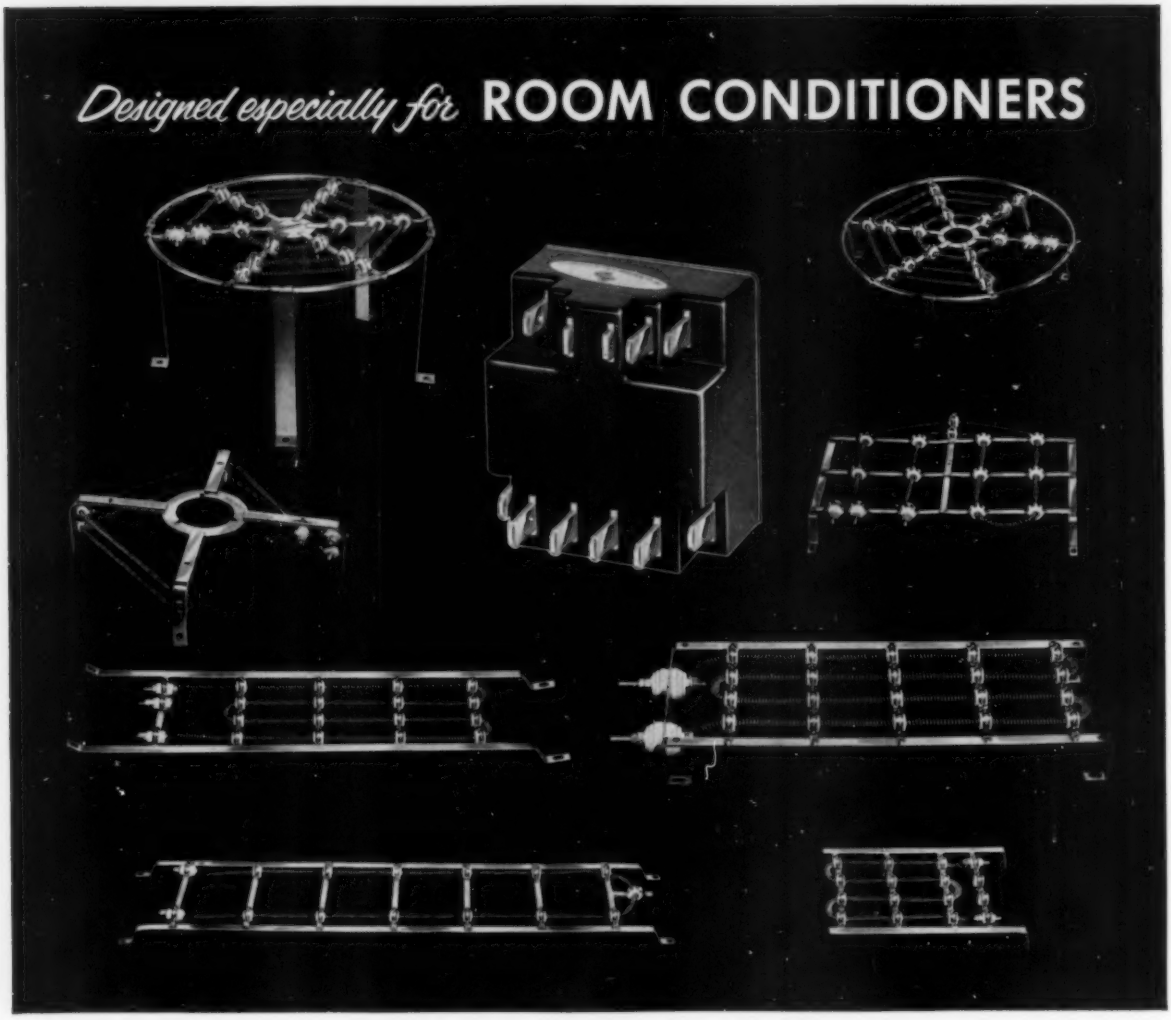

CHECK FERRO FIRST FOR HEATERS AND SWITCHES!

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FERRO ELECTRIC PRODUCTS, INC.

A Subsidiary of Ferro Corporation

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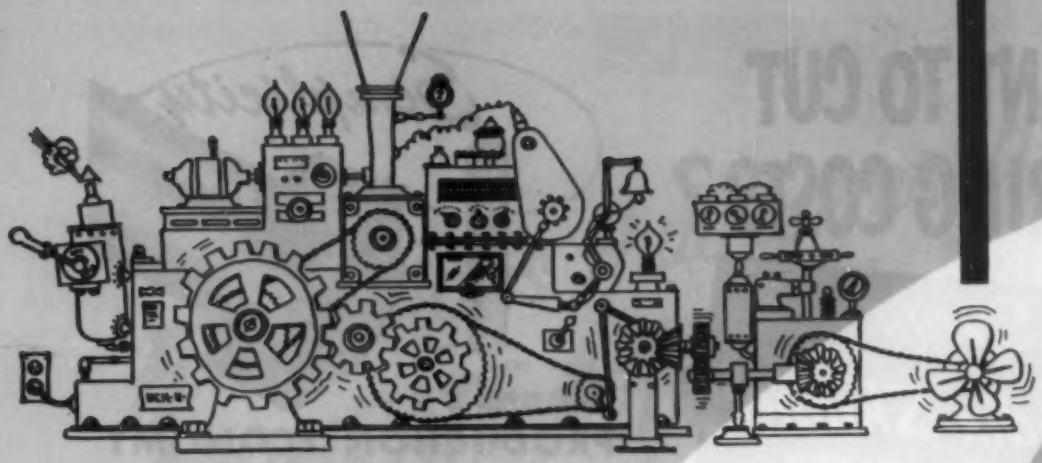

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■ The best way to insure highest efficiency for any mechanical work is to do it the simplest way with the fewest parts that will obtain the desired results.

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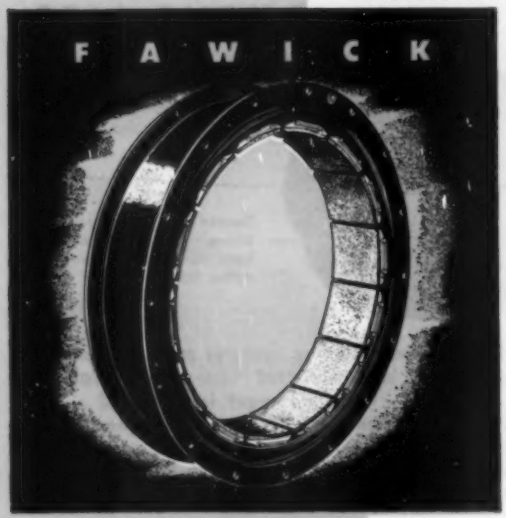

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It seems hard to believe, but you can actually have more efficient filtration at considerably lower cost if you simply use Bendix-Skinner ribbon elements instead of expensive and less adaptable metal edge or metal screen types.

Here's how it works— Bendix-Skinner ribbon elements are inexpensive to begin with and can be installed at far less cost than metallic elements that require special back up supports. In fact, in practically every instance present metallic-type elements can be changed over to ribbon-type with substantial savings.

Ribbon units are available in diameters from ½" to 6" in any required length with filtration rated at 40 microns (.0016").

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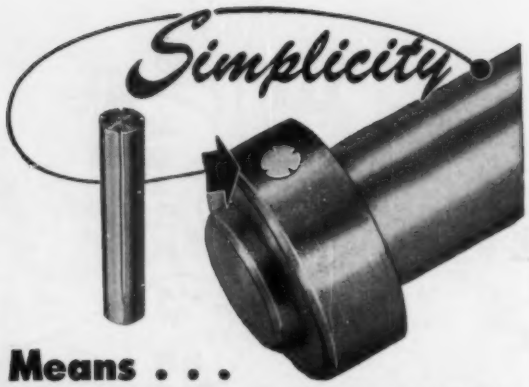

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Assembly of parts like this with DRIV-LOK Pins is simple—fast—more economical. Just drill through collar and shaft and drive in the pin. No reaming or staking necessary. Vibration proof. DRIVLOK Pins are used in many industries for countless applications. Made in many types and sizes to fit your needs. Write for CATALOG showing sizes and applications.

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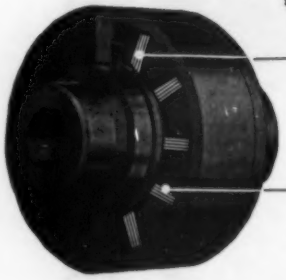
LENGTHENS EQUIPMENT LIFE



Laminated Kantilever Steel Springs transmit driving action.

Tapered slots move point of driving contact inward as loads increase to automatically stiffen kantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

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For Designs that Demand ACCURATE Adjustable Voltage

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variable transformers
Hit the Voltage "On the Nose"

If the equipment you are designing calls for *accurate* adjustable voltage, take advantage of the "precision-accuracy" of a POWERSTAT variable transformer. Plus — its excellent regulation . . . high efficiency . . . cool operation . . . and long life.

And the cost? You can buy a POWERSTAT for as little as $8.50!

POWERSTATS are designed to fit your designs. They make life easy for designers. Dimension-wise and mounting-wise, a POWERSTAT is easiest to install . . . and maintenance is negligible. Write for full details.

Manually-operated and motor-driven POWERSTATS are offered in 120, 240 and 480 volt ratings — from 150VA to 100 KVA.

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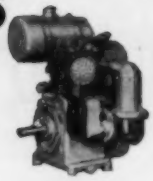
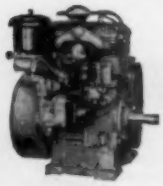


3 to 6 hp.

6 to 9 hp.

Power TO FIT THE JOB

Power TO FIT THE MACHINE



7 to 15 hp.

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In the design, manufacture, and ultimate use-purchase of mechanized field and industrial equipment . . . Wisconsin Heavy-Duty Air-Cooled Engines are specified as Original Equipment Power Components to a greater extent than any other make of engine, within a 3 to 36 hp. range.

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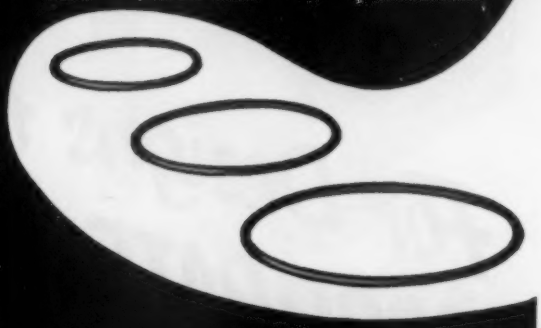
For precision-made seals use LINEAR "O" RINGS



Available from Linear is a wide variety of high-quality, precision-moulded "O" rings for industrial applications . . . also "O" rings to meet the latest government requirements, such as AN or MS types to MIL-P-5516, MIL-G-5510, MIL-P-5315 requirements.

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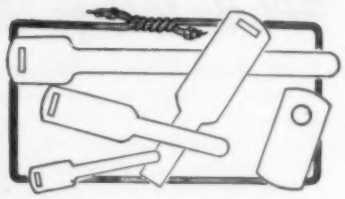

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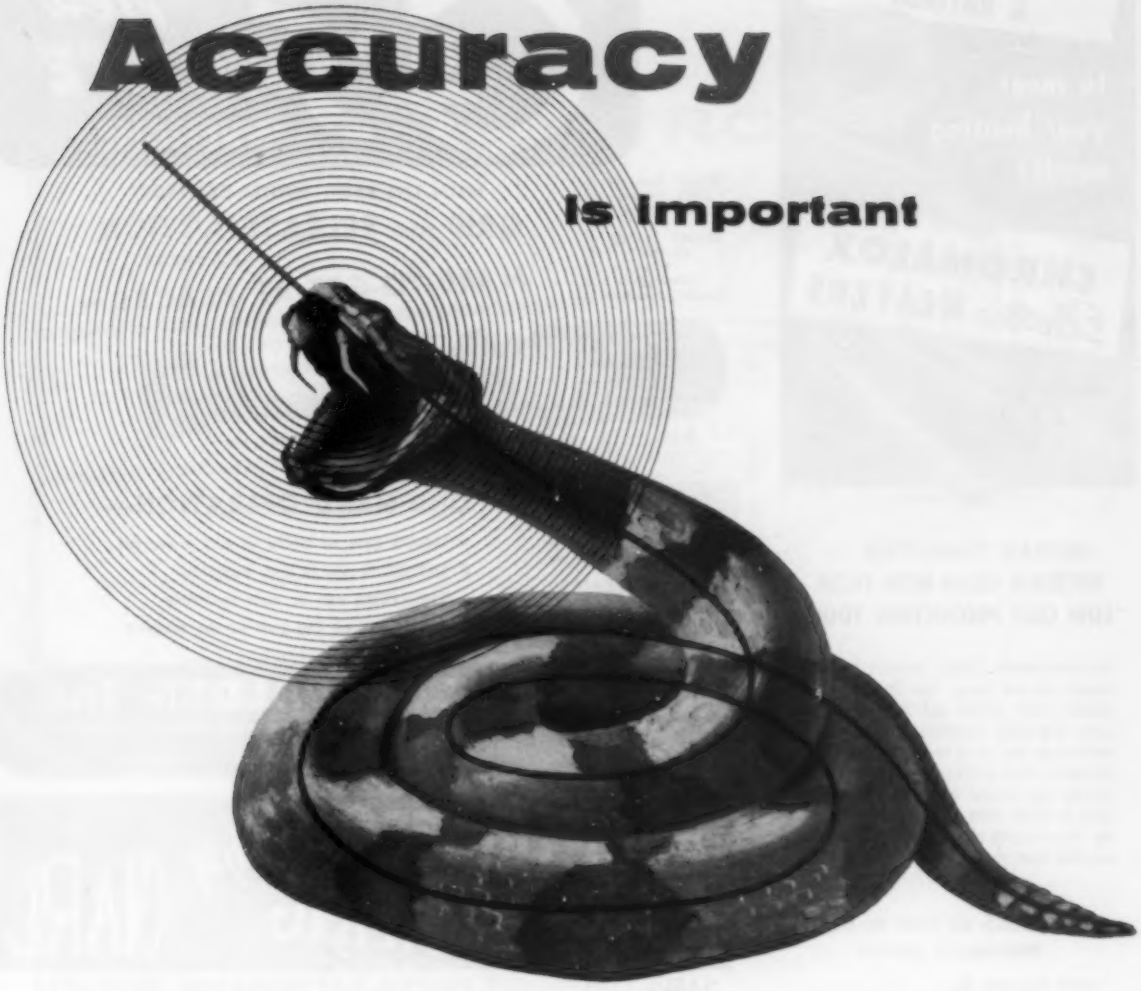

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When close tolerances are imperative, specify Bishop.

Bishop takes special care to control all dimensional tolerances from raw stock to finished tubing. Modern inspection methods, both visual and mechanical, make this possible.

You expect high quality of any stainless steel tubing. You get the added value of close tolerances when you specify Bishop stainless steel tubing.

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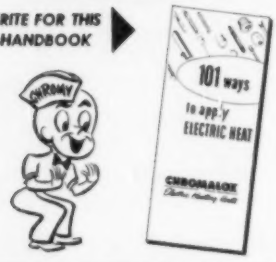

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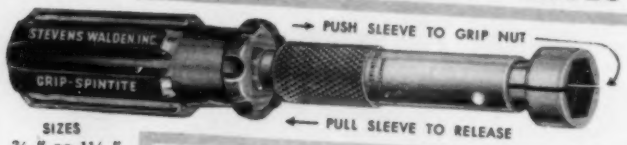

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101-4

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Continuous **WIRE PLATING** to:
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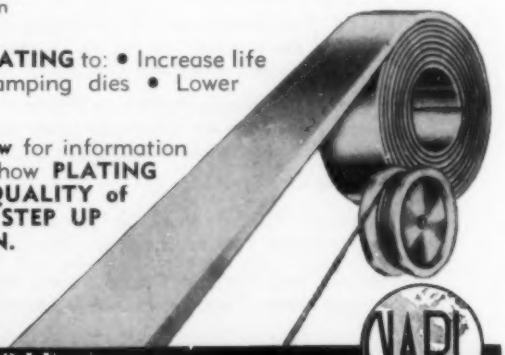

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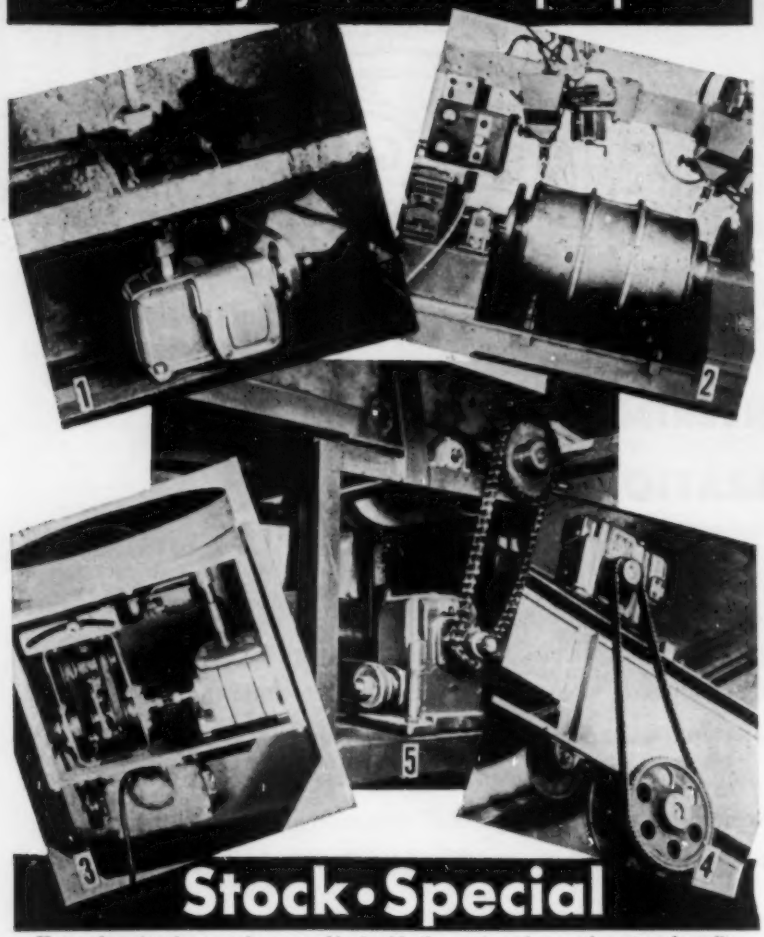

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Every detail of production and workmanship is designed to insure accuracy, durability and years of trouble-free operation.
Illustrated above are a few applications by large manufacturers who depend on Ohio Gear.

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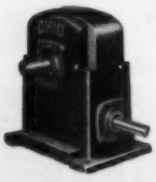
Consult your nearest distributor or write us for complete information.



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Only .94 cu. inches in size—yet it carries 3-amp. loads in the 4PDT combination. It's available up to 6PDT, and with class "H" insulation.

It's extra efficient, too, having only one air gap in the magnetic assembly. By spring-holding the armature rigidly in place, and using cross-bar contacts, all alignment problems are eliminated. Insulation is inorganic, hence there is no gassing or bubbling.

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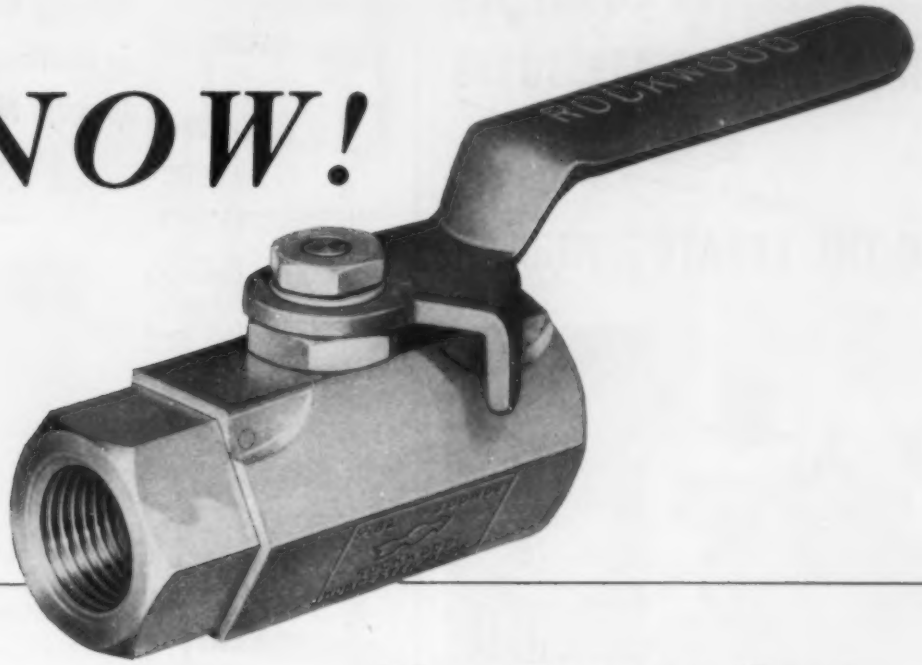

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Put these ball valve benefits in *your* product —

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Famous Rockwood ball valves now come in a choice of models. Get the facts on the new, lower cost steel ball valve. Ask for full details on the original bronze or steel ball valves with their *full* round flow and chrome-plated bronze balls. See coupon for sizes — mail today for complete information on any or all of these long-life valves.

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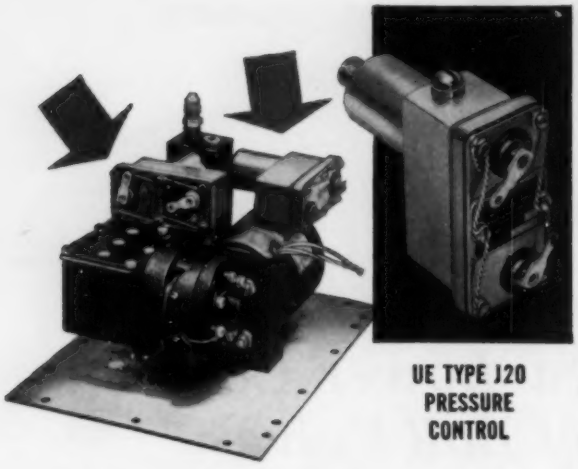
UE PRESSURE CONTROLS MAINTAIN SET PRESSURES IN THE STRATOSPHERE



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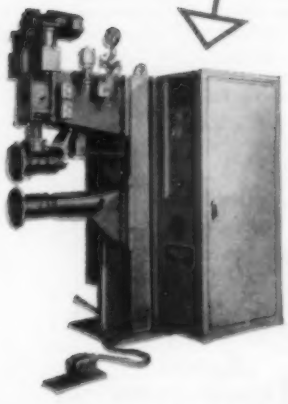

Design Change for Resistance Welding Improves Product, and Lowers Cost

A design change of the cooling fin for their distribution transformer tank enabled Moloney Electric of St. Louis, Mo., to substantially increase production, improve their product, and lower fabricating cost with Sciaky resistance welding. Previously, an "L" shaped fin required two complete passes to arc weld. The quality of the weld and cooling efficiency of the fin depended upon a skilled arc welder. A design change to a "U" shaped fin permitted an *unskilled* worker to resistance seam weld *two* cooling fins with only one rapid pass. The seam weld maintained surface contact for maximum heat conductance, while providing twice the cooling area and reducing fabricating time and cost. For complete details write for R.W.A.W. Vol. 3, No. 7.

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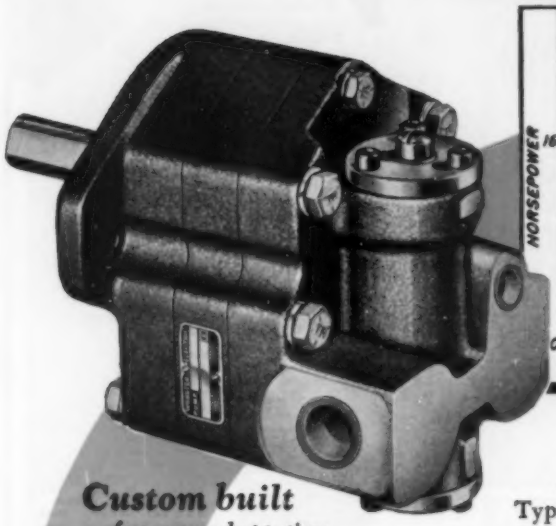

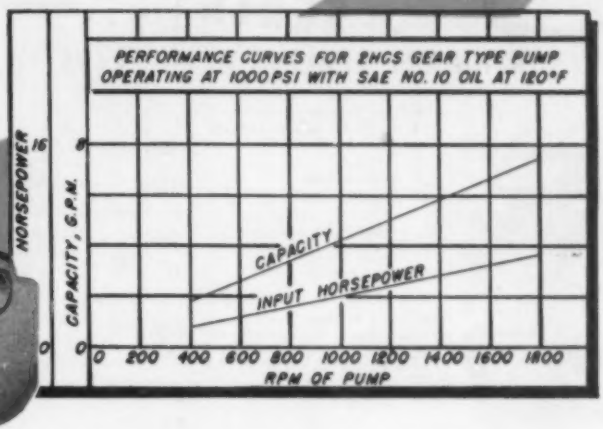

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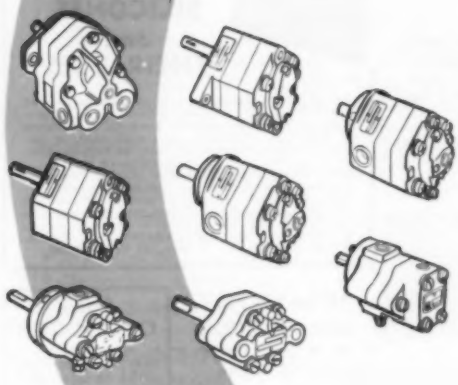

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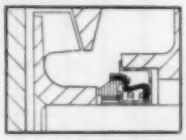
STATIONARY SEALING HEAD TYPE 11-A

A. Seal Retainer.
B. Synthethic Rubber Bellows.
C. Metal Band.
D. Spring.
E. Holding Dents.
F. Precision-Lapped Sealing Washer.



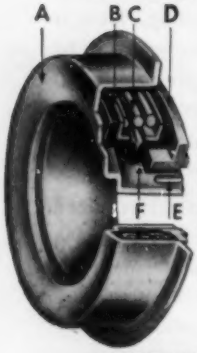
This pressed-in packaged sealing unit is designed with the spiral steel spring inside of the synthetic rubber bellows to protect it against corrosion.

The spring clamps the flange of the bellows tight against the bottom of retainer and the metal ferrule squeezes the top portion of the bellows against the "Teeplelite" washer.

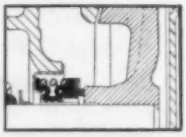
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Low Pressures* to 35 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 6-A



A. Seal Retainer.
B. Metal Ferrules.
C. Spring.
D. Precision-Lapped Sealing Washer.
E. Holding Dents.
F. Synthetic Rubber Bellows.

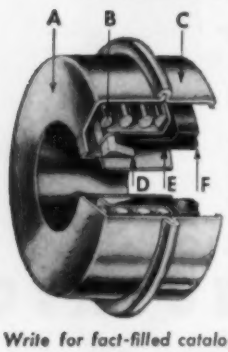


This pressed-in packaged sealing unit is designed with a spiral steel cadmium plated spring (stainless or bronze optional) assembled between two metal ferrules which clamp the flanges of the synthetic rubber bellows tightly against the retainer shell and the "Teeplelite" washer.

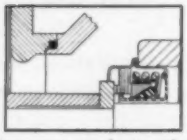
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Medium Pressures* to 75 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 9-A



A. Seal Retainer.
B. Spring.
C. Sleeve.
D. Wedge of Teflon.
E. Sealing Washer.
F. Precison-Lapped Face.



This pressed-in packaged sealing unit is designed to use a wedge sealing ring of Teflon*. This wedge shaped sealing ring closely fits the inner sleeve of the retainer and makes a liquid-tight contact with cone surface of carbon washer.

The result is a liquid-tight seal which is especially recommended for *hot oil, and all chemical liquids or gases, hot or cold.*

Use this seal on: *High Pressures* to 150 PSI
High Temperatures +485°F. *Low Temperatures* −120°F.

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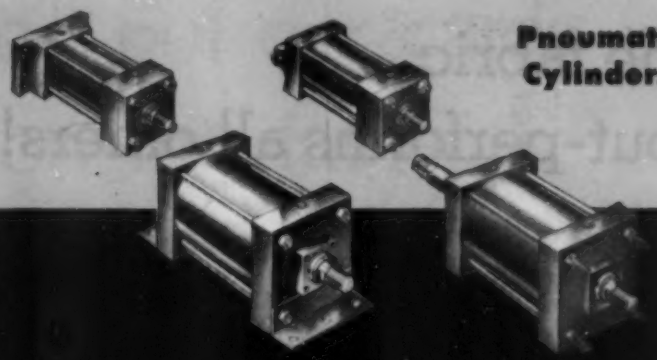

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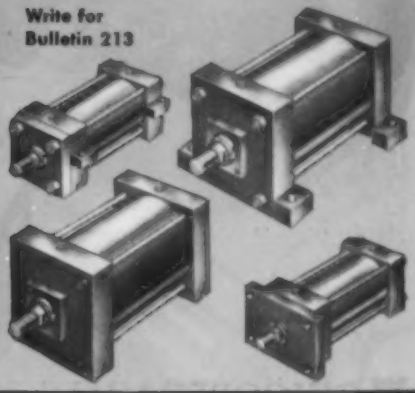

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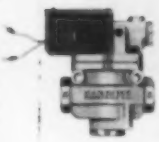

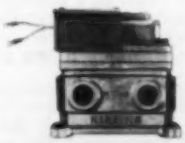

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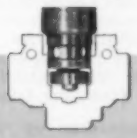

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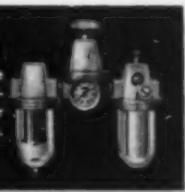

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Write for Bulletin 57-W

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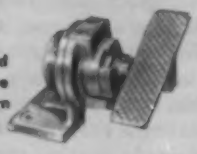

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When you come to us for advice on your plastic molding needs, we'll give it to you straight. Our full house* of the latest, most modern molding machinery is your ace in the hole to beat increased competition. When the chips are down, it pays to have Aico as a partner. Let's arrange a friendly get-together and talk it over. Drop us a line today.

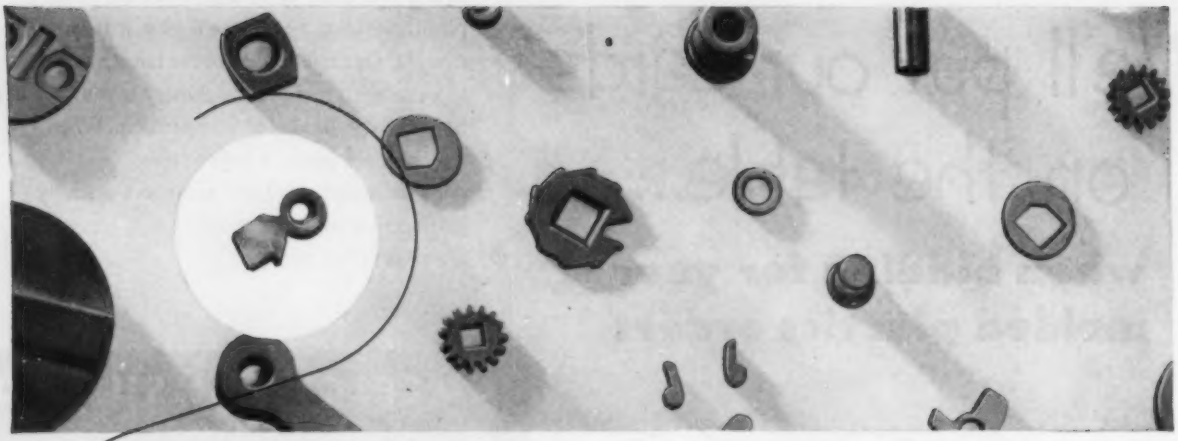
AMERICAN INSULATOR

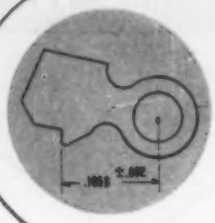
Since 1916

NEW FREEDOM, PA.

*a complete molding service

including engineering counsel, mold making, transfer, compression, injection and cold molding plus the molding of reinforced plastics. With this array of services, Aico is in a position to make unbiased recommendations to your best advantage.





A group of parts, shown in actual size, made from powder metal at National Cash Register Company. Encircled is the business machine counter re-set pawl which is described in the accompanying text.

Need close-tolerance parts . . .

in great quantity . . . at low cost?

Make them of powder metal! Many close tolerance parts, including counter re-set pawls for business machines, are made in one operation by powder metallurgy at the National Cash Register plant in Dayton, Ohio. Variation from specification on the pawls — in some dimensions as close as ±.002 inches — is less in powdered metal than in pieces formerly stamped, shaved and tumbled. Milling operations are eliminated . . . production increased . . . materials saved by eliminating strip scrap.

Powder metal production is *fast* . . . wastes no materials, makes pieces which are impossible or too costly by the usual metal-working methods . . . mechanical strength is comparable with that of machined parts.

Powder metal parts can be "tailored" for tensile strength, hardness, ductility, corrosion resistance, self-lubrication, controlled porosity, or a combination of these factors. Parts with irregular contours or complex profiles, or those imposing severe cutting-waste in their machining, are made in powder metal at savings of 50% to 80%.

Stokes has been building a wide variety of powder metal presses for over 30 years . . . in capacities to apply from 2½ tons to 100 tons pressure. Whatever your requirements, Stokes has the press and engineering "know-how" to help you produce the best part possible with minimum labor and maximum saving.

Send for the free brochure "Powder Metallurgy Today"; send parts, or blueprints of parts, to the Stokes Advisory Service for study and cost analysis.

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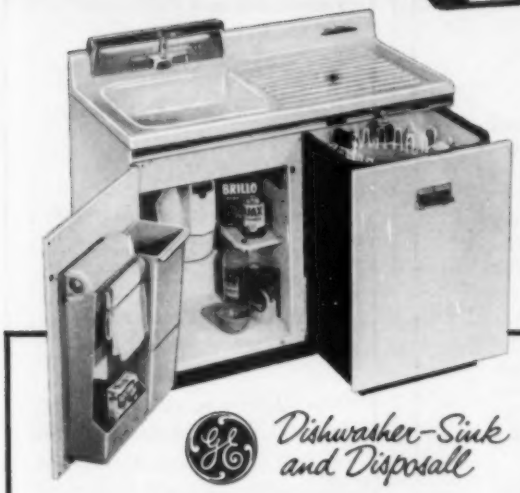
MACHINE COMPANY,
PHILADELPHIA 20, PA.

STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

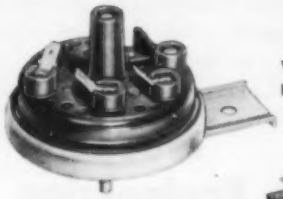
why G.E. says O.K. to Soreng

G. E. Buyer, T. W. Perkins and R. W. Scott, Supervisor of Quality and Production Engineering for G.E., listen to Irving Gebel, Soreng Application Engineer, as he explains the merits of snap switches.



Dishwasher-Sink and Disposall

SORENG PRODUCTS USED ON G.E. DISHWASHER



Water Level Control
Pressure Switch

Snap Action Safety
Interlock Switch

There's an old saw about "a chain is no stronger than its weakest link." By the same token, General Electric figures an appliance is no better than its smallest part. So G.E. component specifications demand highest quality, dependability and performance . . . *at the lowest possible cost.*

Sure, "high quality at low cost" is an old saw too. But we've put new teeth in it. Soreng electrical components are designed to last the life of the products on which they're used. You get custom design and custom quality at low first cost—plus low cost per year of service life. That's why G.E. says O.K. to Soreng.

So if you're adding new features to your product while lowering the cost, why not discuss the problem with a Soreng engineer? Or, if you want to "know more" about Soreng first, send for our new Data Folder showing examples of custom designed switches, solenoids, etc. for the Appliance, Automotive and Aircraft Industries.

SP

Data Folder contains product bulletins, drawings, technical data

SORENG

• PRODUCTS CORPORATION

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Plants: Schiller Park, Illinois • Spring Valley, Illinois • Fremont, Ohio

An Invitation To

AERODYNAMICISTS

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New concepts of flight for the jet era . . . as well as engineering advances on the world-renowned C-119 Flying Boxcar and soon-to-be-produced C-123 Assault Transport are coming from Fairchild. Diversified, stimulating assignments like these increase the inventive challenge to Fairchild's team of qualified aerodynamicists.

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Aircraft Division

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has been in preparation since last November. It will be published in October, and will come to you as part of your regular subscription to *Product Engineering*.

The 1955 HANDBOOK, like the first two HANDBOOKS of 1953 and 1954, will bring you a broad assortment of data covering every field of product-engineering. This data . . . authoritative, complete, and thoroughly illustrated . . . will be sectionalized into ten major areas of your interests:

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De Laval IMO and CPO pumps have solved problems on a wide range of products—hot or cold, acidic or alkaline, viscous or corrosive, clear or filled with suspended solids. IMO and CPO models are available for early delivery.

Your De Laval representative is an experienced application engineer. Consult him on your pumping problems.

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capacities to 750 gpm
pressures to 1500 psig
Write for Bulletin LG-A

DE LAVAL CPO PUMPS
capacities to 2000 gpm
heads to 200 feet
Write for Bulletin 1125-B

DE LAVAL *Pumps*

DE LAVAL STEAM TURBINE COMPANY
801 Nottingham Way, Trenton 2, New Jersey

DL 336A

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for close-up visual inspection of internal surfaces and hidden parts

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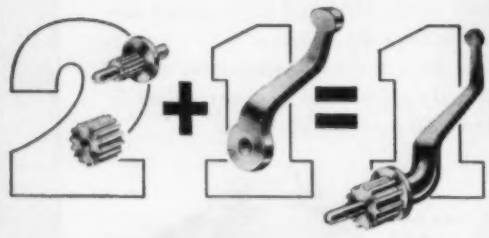
Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.



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Add parts and operations and you add cost . . . GRC reduces operations, makes small parts in ONE low-cost die casting. Gries methods speed production, prevent waste, offer design improvement. If you use small parts, chances are that Gries engineers can show you how to simplify—and save.

Fast delivery of 100,000 completely finished small parts—to many millions. ***Write today for bulletin and samples. Send specifications for prompt estimates.***

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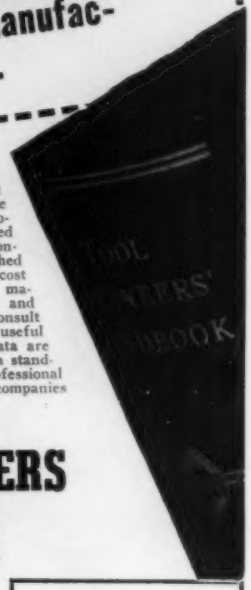
GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings
159 Beechwood Ave., New Rochelle, N. Y. Phone: NEw Rochelle 3-8600

An outstanding reference on all phases of planning, control, design, tooling and operations in the mechanical manufacturing industries.



THIS Handbook brings you the most modern, authoritative data on the design, fabrication, maintenance and economical use of tools and machinery used in industry. Of importance to anyone connected with mechanical processing of finished products, it covers product design and cost estimating, the economical selection of machines, processes and tools, the analysis and improvement of set-ups and operations. Consult it for rules, formulas, procedures and useful data. Use it with complete confidence; data are based, wherever possible and practicable, on standards established by the government, the professional associations, and leading industrial companies throughout the country.

TOOL ENGINEERS HANDBOOK

American Society of Tool Engineers

Frank W. Wilson, Editor-in-Chief

Written by 144 authorities in the field, this massive reference has been checked and double-checked to insure accuracy from cover to cover. Here are the complete authoritative answers to problems you meet from day to day—brought to you in compact, easy-to-find form.

More than 2000 pages! Over 1500 illustrations! Hundreds of tables, charts, keyed diagrams, symbols, definitions, equations, etc.

A small selection of highlights selected at random to illustrate the scope of this Handbook:

—Describes types of machines, cutting tools, toolholders, fixtures and operations in precision production boring.
—Includes all new techniques and processes of recognized acceptance including Powder Metallurgy, Investment Casting, Plastic Joining of Materials, etc.
—Conventional tables of feeds, speeds and cuts modernized to bring them into line with latest cutting-tool materials and cutting practices.
—Treats, process-wise, such topics as Plaster Mold Casting, Superfinishing, Rotary Swaging, Sheet and strip cold roll forming, Die Hobbing, etc.
—Covers every phase of metal cutting and machinability.
—Discusses welding, gluing and mechanical joining of materials.

Partial Listing of the Handbook's 115 Big Sections which Cover Tool Engineering from A to Z:

- Job Planning and Control
- Small Tools Planning and Control
- General Structure and Properties of Metals
- Properties and Workability of Plastics
- Plastics Forming
- Inspection Equipment and Methods
- Investment Casting
- Milling
- Shrinkage Fits
- Broaching
- Engine Lathes
- Power Bandsawing
- Gear Shaping
- Jigs and Fixtures
- Thread Chasing
- Pressworking of Metal
- Allowances and Tolerances for Cylindrical Fits
- Static and Dynamic Balancing
- Shot Peening
- Punches and Dies
- Drilling, Reaming and Counterboring
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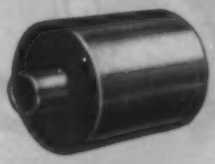
is a proven way to "stifle" the shakes

Shock mount to cushion and reduce magnitude of sudden shock.



Bearings and bushings for torque action and oscillating movements . . . no lubrication required.

Rolling joint type to dampen and isolate vibration, reduce noise transmission, cushion shock loads.

General Silentbloc mounts can do something about the universal plague of vibration, shock and noise in equipment ranging all the way from delicate instruments to heavy machinery.

Silentbloc mountings, bushings and bearings are being used today with outstanding success in automotive, refrigeration, industrial, aeronautical, marine, electrical, agricultural, household and dozens of other fields. These units can be custom designed and manufactured in any size and type.

For an engineered appraisal of your vibration problem send us the facts on your company letterhead. For a free design guide to vibration control fill out the coupon below.

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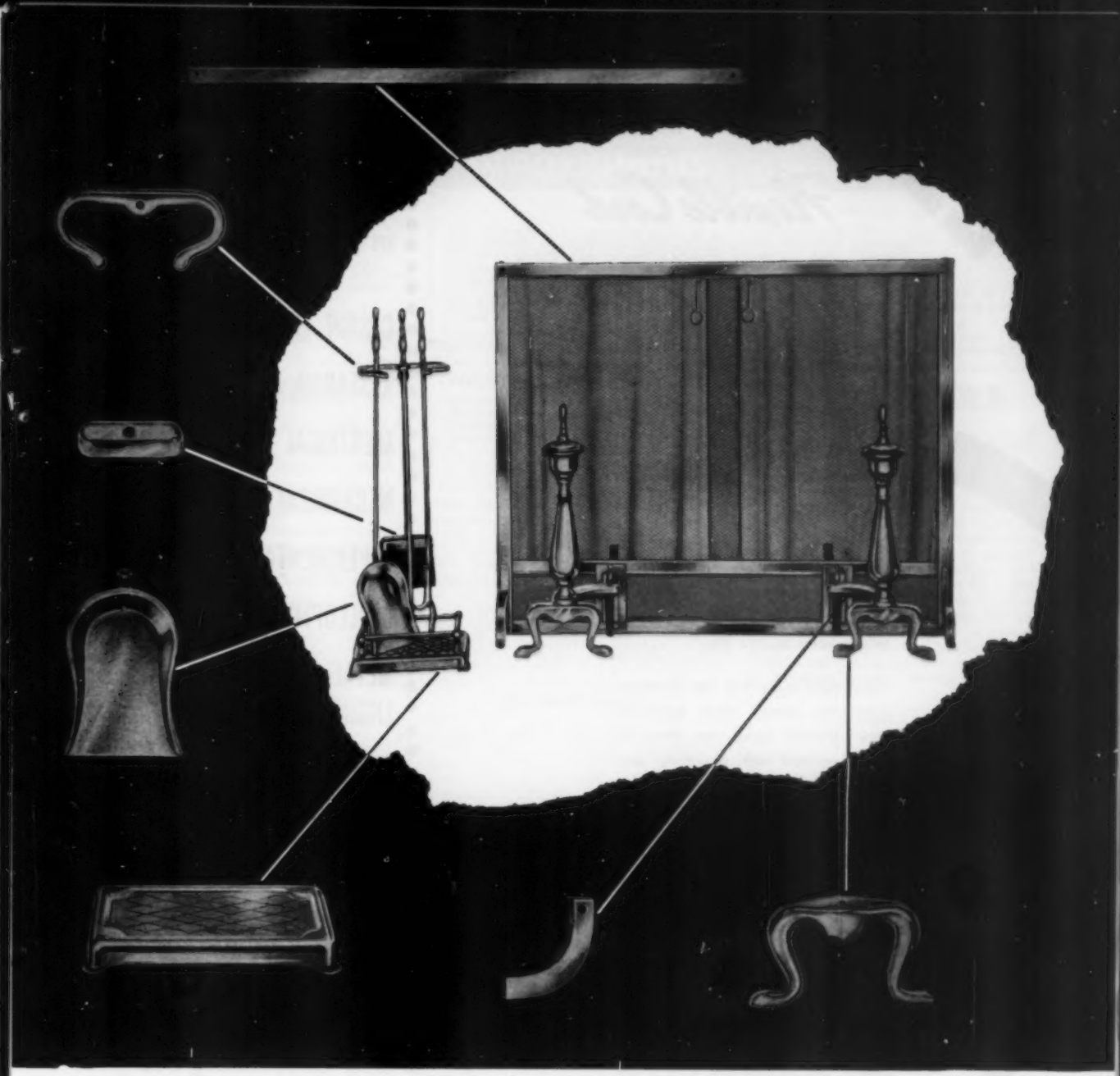
- ☐ **Check contents** and locations of first-aid kits.
- ☐ **Send staff** to Red Cross courses. They may save your life.
- ☐ **Promote preparedness** in your community. Your local CD Director can show you how.

Set the standard of preparedness in your plant city—check off these four simple points NOW.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Product Engineering



FORMBRITE'S SUPERFINE grain structure enables Special Products Co. to buff this equipment in half the time necessary with ordinary brasses.

New kind of brass called "FORMBRITE" cuts finishing costs

The bright, lustrous finish you see on this fireplace equipment – made of FORMBRITE* sheet metal – is the result of a simple color buff that took about half the time previously required. FORMBRITE's appearance after buffing speaks for itself.

FORMBRITE's superfine grain structure provides a surface far superior to ordinary drawing brasses. In every case, it's meant important savings in finishing costs . . . *and* improved product quality.

FORMBRITE is readily formed, drawn or embossed . . . results in products that are harder, stronger, "springier" and more scratch-resistant.

But don't take our word for it. Read what others say about this specially processed drawing brass:

Niagara Searchlight Corp. – "Cuts polishing and buffing time on flashlight end caps 50% . . . plating and general quality are improved, too."

Aeroplane Tackle Mfg. Co. – "We cut polishing costs over 25% . . . on several stamped products we get the required finish by a simple tumbling before lacquering or plating."

Sheaffer Pen Co. – "Savings in polishing costs are as high as 50%. Formbrite gives us a longer-lasting product."

Yet with all the plus values FORMBRITE offers over conventional brasses *it costs no more.* You can do it better, faster and cheaper with FORMBRITE. Want a sample? More information? Write: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* *Reg. U. S. Pat. Off. 5488

Formbrite

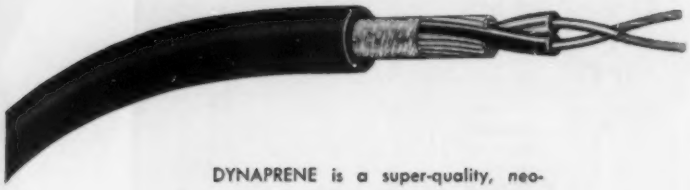
an ANACONDA® product

made by The American Brass Company

DYNAPRENE®

Flexible Cord

IS *MADE* TO LAST



DYNAPRENE is a super-quality, *neoprene*-jacketed flexible cord designed specifically to provide the greatest resistance to impact and flexing — those twin menaces to cord life.

DYNAPRENE is cured by the continuous vulcanizing process which assures a cord uniformly cured, free from deformation, and with accurately centered conductors.

DYNAPRENE is resistant to oil, moisture, gas and acid fumes and withstands the usually destructive effects of sunlight and aging. It wears longer because it is tough and far exceeds the Underwriters' minimum requirements for Types SO, SJO and SV neoprene-jacketed style cordage.

DYNAPRENE, a cord of the highest quality, can be depended upon to deliver power where and whenever it is needed.

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They are the readers of this publication. You can secure their services by advertising where they will see it—in our classified advertising section starting on page 385 in this issue.

Copy must be received at 330 W. 42nd St., N. Y. 36, N. Y. by July 16th to be in the August issue.

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CENTRIFUGAL CASTINGS...

Better
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New Products Wanted.
Manufacturer desires products to develop, engineer, manufacture or market. Research and development departments engineer for cost saving production. If suitable for our production facilities, will consider license agreement or purchase. Protection assured. Conray Corporation, 1225 Ray Street, Dayton, Ohio.

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P3142 Product Engineering
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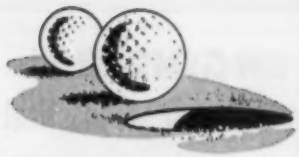

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Then by all means let us tell you about Melpar and the interesting assignments it can offer qualified men. We're increasing our engineering staff again . . . for the eighth consecutive year — and that means a real "ground-floor opportunity" for you.

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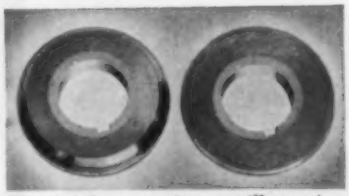

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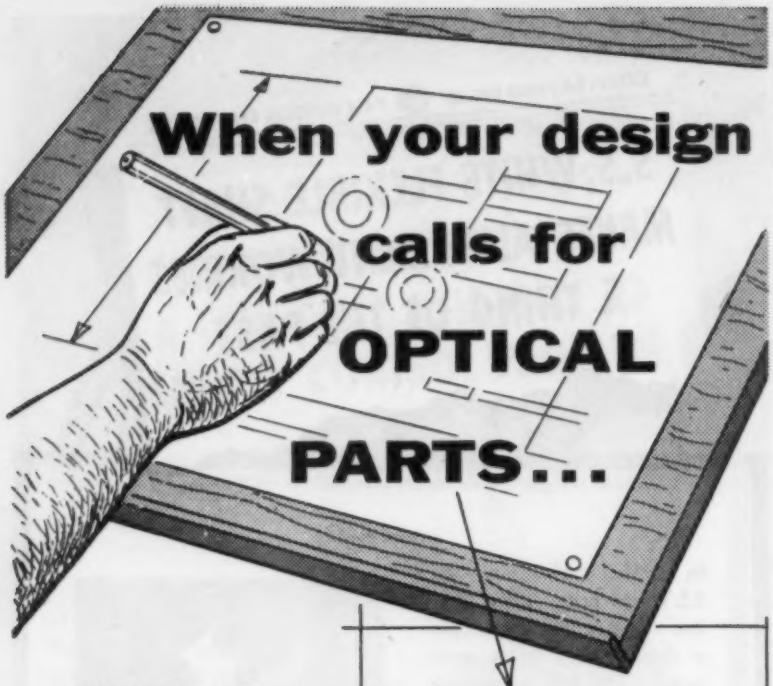

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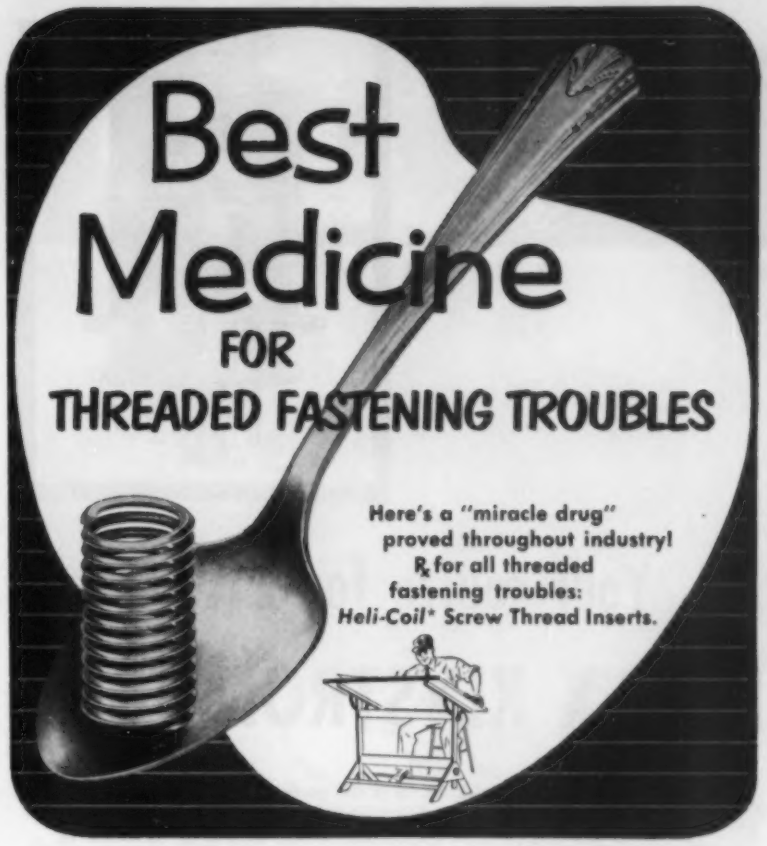

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Tuner Cathode Current	10 ma. D.C.

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Heater Voltage (A.C. or D.C.)	6.3 volts
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Min. Power Output at 23504 Mc/Sec.	8.5 mW.
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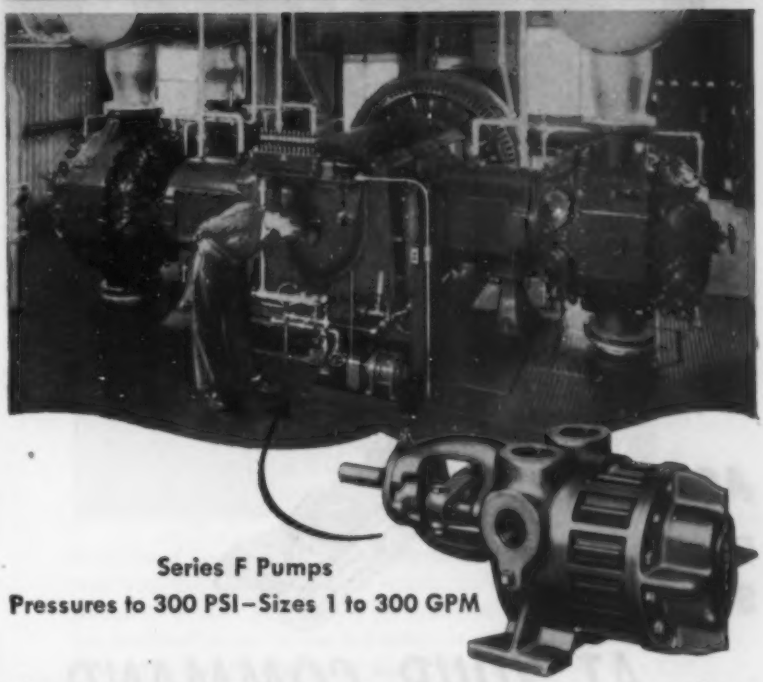

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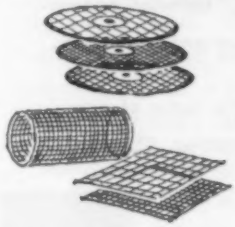

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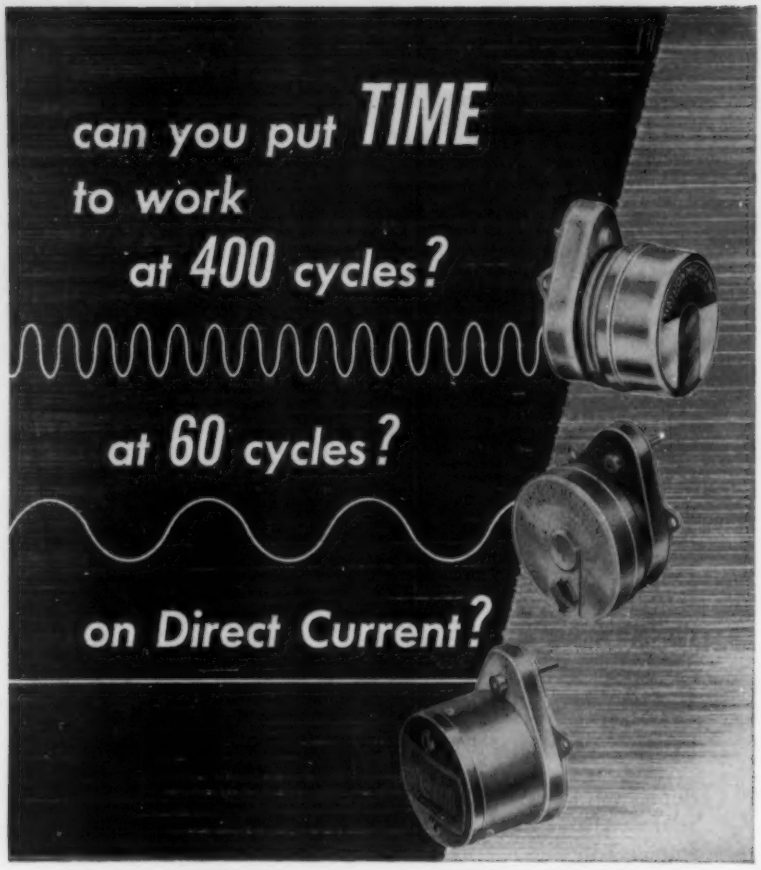

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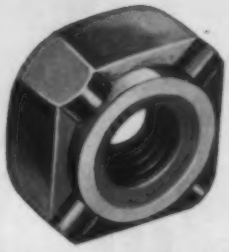
For Speedy... Economical Assembly

SPECIFY MIDLAND Welding Nuts



Ideal for Hard-To-Get-At Places ...Will Not Work Loose or Rattle!

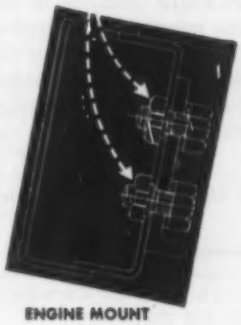
Whether you're designing a product or building it, the Midland Welding Nut is the answer to the problem of accurately and securely fastening metal parts into a main assembly . . . speedily, economically.

It is welded to the parts so that a bolt can be turned into it without the need for any device to hold it and keep it from turning.

This frequently means that one man can do the work of two, for with an ordinary bolt and nut one man usually has to hold the nut in place while a second man turns the bolt into it.

Midland Welding Nuts are perfect, too, for those hard-to-get-at places in assembly operations. Welded in advance to those inside spots where it is difficult —or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

Write or phone for complete information *today!*



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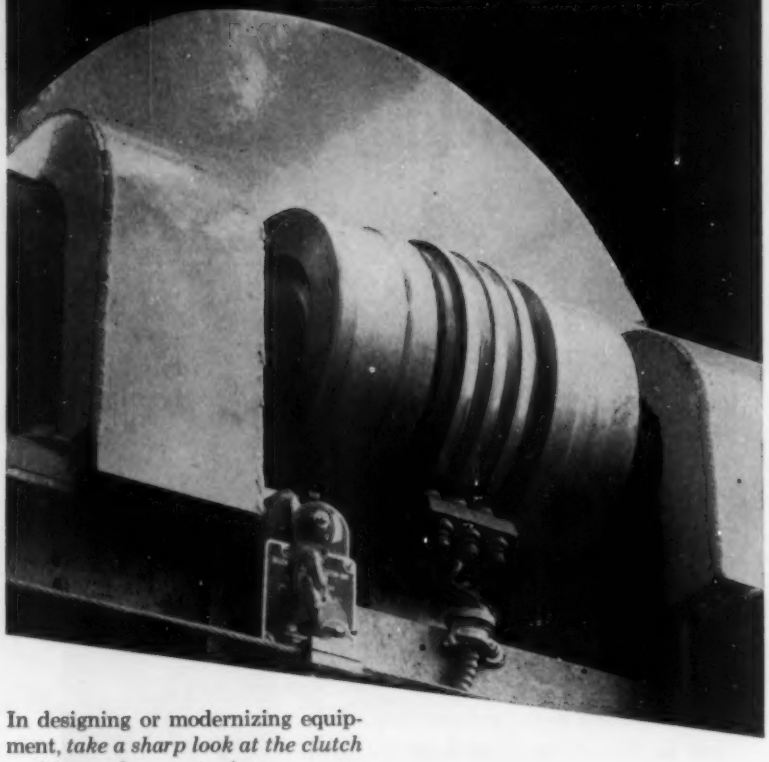
Manufacturers of

AUTOMOBILE AND TRUCK FRAMES | AIR AND VACUUM POWER BRAKES | AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS

Stearns can help you cut costs— IN THE CLUTCH



In designing or modernizing equipment, *take a sharp look at the clutch* — it's one key spot where you can hit high operating costs.

And you can hit these costs hard with a matched-to-the-machine Stearns magnetic clutch or clutch-brake combination. Here's why:

In addition to Stearns wide range of standard models, Stearns will custom-build clutches to fit your machine exactly — no makeshifts, no "almost rights." Stearns clutches provide split-second engagement or disengagement—help machines hold close tolerances.

Make these Stearns advantages work for you:

WIDE TORQUE RANGE — .4 to 30,000 lb foot. Handles everything from business machines to steel mill screwdowns and ball and rod mill drives.

LOW INERTIA — Fast, smooth engagement and disengagement.

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EASY WEAR ADJUSTMENT — Provides longer clutch life.

SIMPLE INSTALLATION — No toggles, yokes, shifters.

For full details consult your 1954 Sweet's Product Design file or write for Bulletin 226-C-4. 1095

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TIC-TALKS FEATURE

TYPE RVHT

HIGH TEMPERATURE TRIMMER POTENTIOMETER

. . . ideal for calibration, balancing, bias adjustment and similar functions in circuitry of Thermocouples, Pyrometers, Bolometers, or Strain Gauges making accurate measurements in high ambient temperature.

Typical operations where the high temperature characteristics of this potentiometer are most useful are in association with instrumentation of:

The ambient temperature range is −55°C to +145°C. Stability is assured by pre-aging through temperature cycling. Rugged construction resists deterioration due to shock, vibration, humidity, salt spray, and corrosive atmosphere.

High resolution permits precise setting.

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Ganging: Sections may be combined in ganged assemblies on a single shaft. One-piece stainless-steel clamp-ring permits precise phasing among ganged sections.

Mounting: Threaded bushing. Shaft locking device provided.

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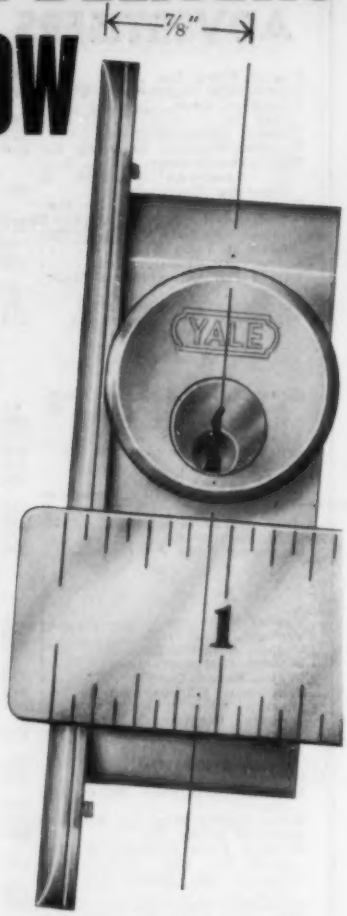

Only 1½ inches "wide" with a ⅞-inch backset ...yet it doesn't surrender a single Yale security or quality advantage!

FOR NARROW STILE DOORS

It took YALE engineering ingenuity to provide you with this "narrow escape" from the problem of dwindling entrance door stiles.

Designed promptly at the request of the nation's leading manufacturers of glass and metal entrance doors . . . the new, narrow YALE deadlock is just what you've been looking for.

***In addition** to being only 1½ inches wide and having a ⅞-inch backset, all these other YALE features are retained:*

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- **Pin tumbler security.**
- **Availability of single cylinder operation, when desirable.**
- **Convenience of master-keying.**
- **Handsome construction in anodized, extruded aluminum stock.**
- **Hardened steel pins in bolt.**

For additional information about the new, narrow entrance door deadlocks, write today to: The Yale & Towne Mfg. Co., Stamford, Conn.

SEE THE YALE INDUSTRIAL MAN
He has the answer to your lock problem

YALE & TOWNE

So once again YALE proves its ability to design, engineer and produce a lock to solve special problems.

YALE has competent industrial lock experts in major markets across the country. Chances are, there's one in your vicinity now. He'll gladly give you full details about the entire line of YALE locks, without obligating you in any way.

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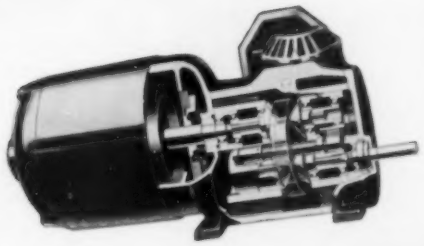

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SIZES. ¼ to 5 HP with speed ranges up to 8 to 1.

FEATURES. Long life all-metal construction, very compact unit gives constant torque, infinitely variable speed operation.

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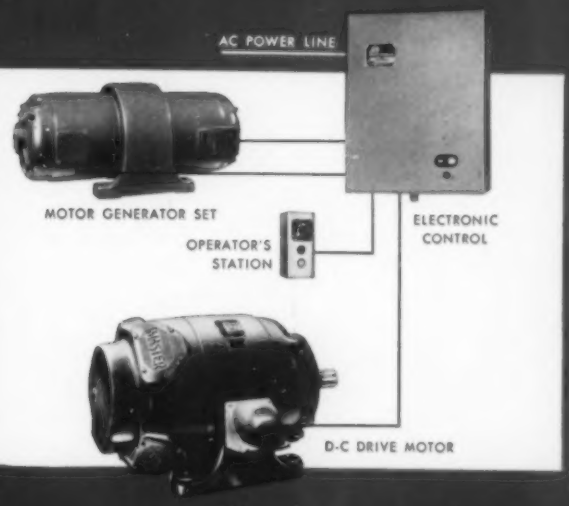

THE RIGHT SPEEDRANGER CAN MAKE A BIG DIFFERENCE

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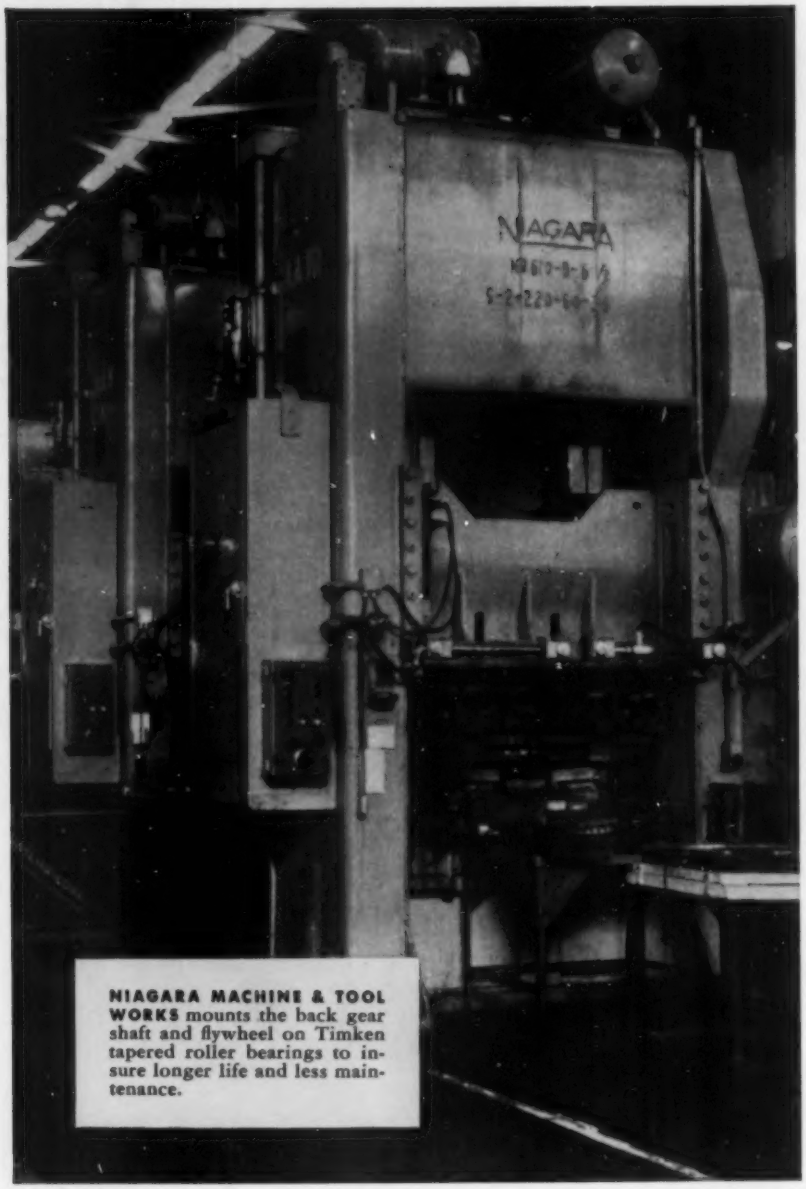
THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

How TIMKEN® bearings cut maintenance on auto body stamping presses



NIAGARA MACHINE & TOOL WORKS mounts the back gear shaft and flywheel on Timken tapered roller bearings to insure longer life and less maintenance.

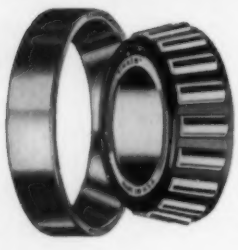
MAINTENANCE and downtime are low in the stamping department of one large automotive manufacturer. One reason: 30 new-design Niagara double crank presses have the back gear shaft and flywheel on Timken® tapered roller bearings.

Every time the press stamps a part, the bearings on the back gear shaft take the heavy shock load. Timken bearings take these loads with ease because rollers and races are case-hardened. This gives them a hard, wear-resistant surface over a tough, shock-resistant core. Full line contact between rollers and races of Timken bearings gives them extra load carrying capacity to hold shafts in line. There's minimum maintenance, less downtime.

Timken bearings help gears last longer, too. They insure accurate gear mesh because Timken bearings' tapered construction lets them take both radial and thrust loads in any combination. The taper prevents lateral movement of the shaft. Flywheels do not become worn or loose, crankshaft wear is prevented.

Be sure to specify Timken bearings for all the machinery you build or buy. They give longer life with less friction. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, O. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



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TAPERED ROLLER BEARINGS

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

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